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**References to Notes in "Abstracts from Foreign Contemporaries" are distinguished by an asterisk preceding the page number. Descriptions of central station plants are indexed only under the head "Central Station" and the names of the cities.*

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AUTHOR INDEX

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TYPICAL AMERICAN HYDRAULIC AND TRANSMISSION PLANT

AMERICAN RIVER ELECTRIC COMPANY'S SYSTEM.

BY C. W. WHITNEY.

The American River Electric Company has recently completed and placed in successful operation in central California a hydro-electric power and transmission system, which is typical of the best water-power plants on the Pacific Coast. The plant has nothing of the spectacular about it, unless it be that it is located on one of the most picturesque mountain streams in California; but it is characterized by a high standard of construction and well merits description. Special mention will be made further on of several unusual and noteworthy engineering features which have been worked out in the design and construction of the system.

The generating plant of the American River Electric Company is located on the South Fork of the American River about six miles from Placerville, which, in turn, is 90 miles by railroad east of Sacramento. Power is supplied over an 80-mile circuit to Stockton and over a 30-mile line to Folsom and vicinity; while lines to Sacramento and other points are projected for the near future.

The American River and Silver Creek, its principal tributary, have their heads on Pyramid Peak, Mt. Tallac and other snow-covered peaks of the Sierra Nevada Mountains in Eldorado County. The waters from Echo and several other lakes are included in the drainage basin of the American River, while the same watershed sends its waters on its eastern slope into the beautiful and much renowned Lake Tahoe. The drainage basin of the South Fork of the American River covers about 550 square miles. In the deep ravines and on the shaded slopes of the higher mountains the snow remains the year round, so that the permanence of the water is always assured. The American River flows through a section that is quite heavily timbered with pine, cedar and spruce, and extensive lumbering operations are still being carried on a few miles above Placerville. In the section where the American River Electric Company has done its hydraulic development, a portion of which is shown in Fig. 1, the river flows between banks which rise from 1,000 to 1,500 feet and are still covered with much of the virgin forest. In the 7½-mile length of the river bed between the company's dam and its power house, the river has an average fall of between 75 and 80 feet to the mile, and the canal system that has been constructed utilizes this fall to give a total static head at the power station of 575 feet. The river has a minimum recorded flow of about 100 second-feet at that point, while the maximum flow is, of course, high. When some of the accompanying pictures were taken there was a flow of about 5,000 second-feet in the river, while Fig. 6-E shows it at low-water stage.

FIG. 2.—POWER HOUSE, SHOWING PIPE LINE AND ROCK CREEK.

FIG. 1.—GENERAL VIEW OF POWER HOUSE, TRANSFORMER HOUSE AND SWITCHES, WITH TRANSMISSION LINES CROSSING RIVER.

The company's dam spans a narrow place in the river at a point about 12 miles from Placerville. The dam is of a timber-crib, rock-filled construction and abuts on bed rock at each end. It is 210 feet long, 30 feet high and has a width of 50 feet at the bottom and 19 feet at the crest. A gen-

eral view of the dam and headworks is shown in Fig. 6-C, while Fig. 6-H shows the dam and the reservoir created by it. The water is backed up in the canyon for about half a mile, the purpose of the stored water being principally to equalize the irregular flow of the river caused by evaporation, raises, etc. The headworks, Fig. 6-C, of the canal line, are located at the north end of the dam and consist of heavy wooden gates raised and lowered by handwheel screws.

The water is taken from the reservoir at a point near the surface, thus giving the flume over 20 feet elevation above the river bed at the start. The total length of canal line from the dam to the penstock above the power-house is a little over seven miles, being exactly 37,283 ft. 5 ins. The general contour of the canal is shown in Fig. 3. Wherever it was possible, ditching was resorted to, but on the upper portion of the work a wooden flume had to be depended upon and over four miles of it was built, the longest single stretch being 14,202 feet long.

Fig. 4 shows the construction of the flume, the trestle supports varying, of course, to conform to the nature of the ground covered. The framework consists of 4-in. x 6-in. x 6-ft. 6-in. posts, braced by 4-in. x 4-in. pieces to 4-in. x 8-in. x 8-ft. sills that rest on 6-in.

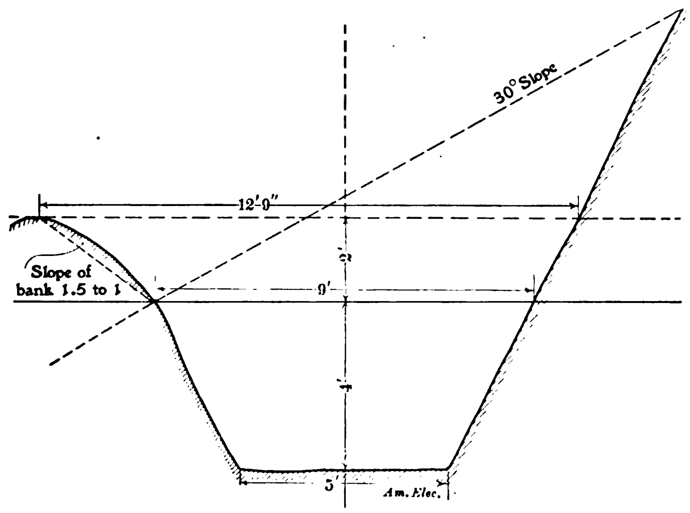

FIG. 3.—DITCH DETAIL.

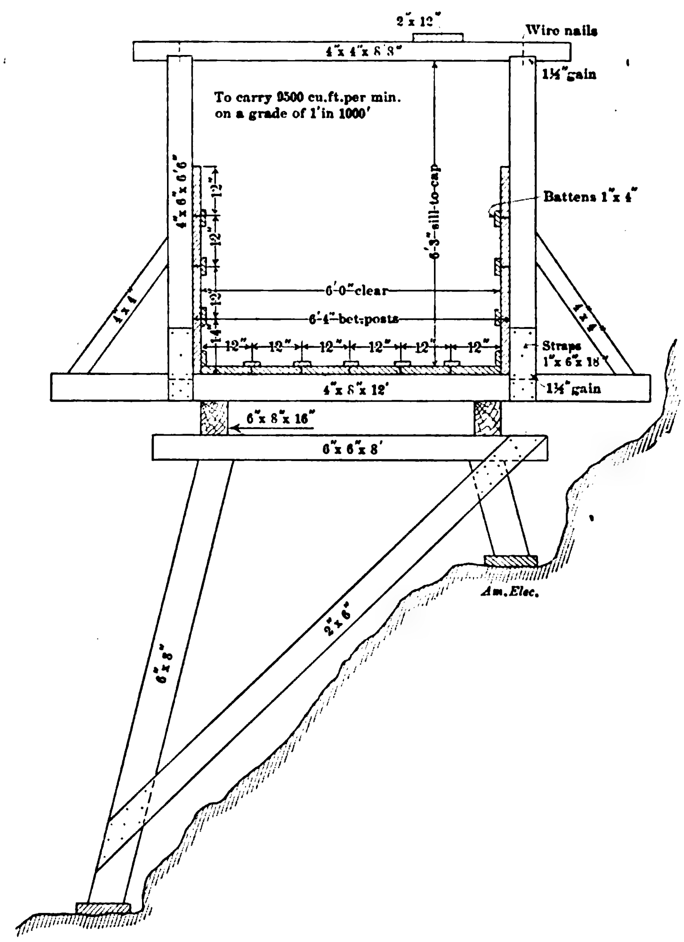

FIG. 4.—FLUME DETAIL.

sills that rest on 6-in. x 8-in. x 16-ft. stringers. The bents are placed 16 feet apart and between them are three sets of intermediate posts. The flume is planked to a height of four feet with 2-in. x 12-in. plank, giving a clear width of 6 feet. The planks are battened with ¼-in. x 4-in. strips, battens as well as the floor and side planks being surfaced so that the flow of the water is smooth and even. There is a clear height in the flume to the caps of 6 ft. 3 ins., and with the sides planked 6 feet high the flume will have a capacity of 264 second-feet of water. At present the company is using about 50 second-feet. The flume and ditch have been built with a drop of 1 foot in 1,000, so the total drop in the canal line is nearly 40 feet—sufficient to give the water a velocity of about 4.4 feet per second. Figs. 6-I and 6-M illustrate typical flume sections, Fig. 6-J is a view showing a tributary creek fall on the right, and Fig. 6-A is a scene about the middle of the canal.

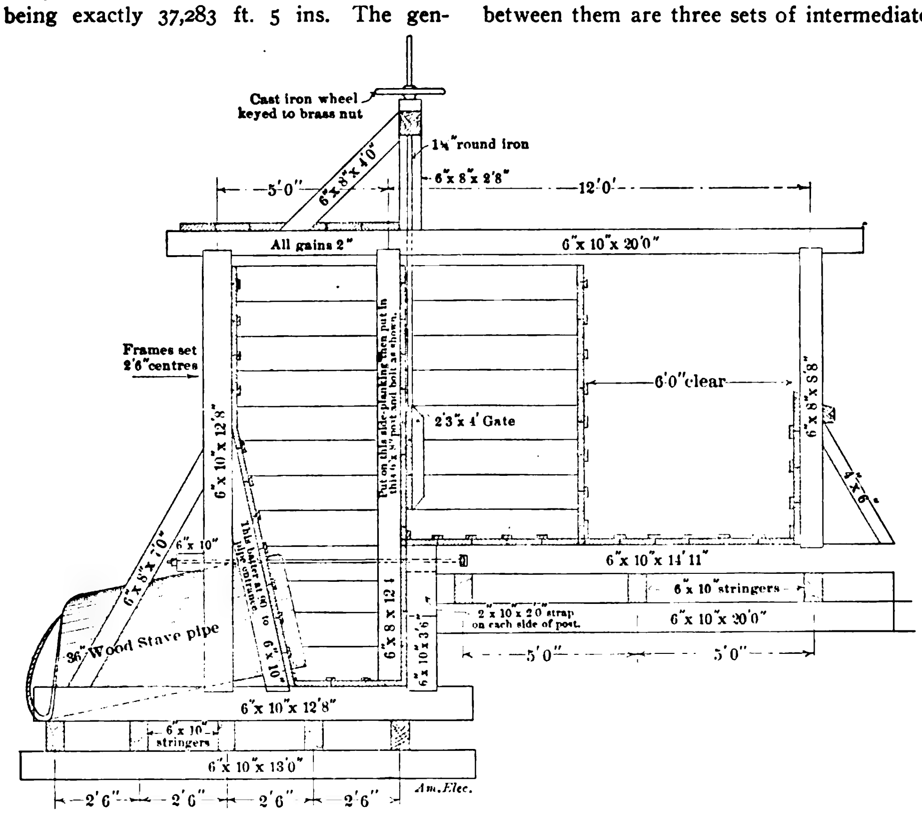

FIG. 5.—SECTIONAL VIEW OF PENSTOCK.

Ditching was used where the banks of the river are less steep and where there would be comparatively little danger or rock or land slides. The standard ditch construction is that shown in Fig. 3, the ditch having a width of 5 feet at the bottom and 12 ft. 9 ins. at the top of the lower bank which is placed 6 ft. above the bottom. On a 30-degree slope the excavation per linear foot amounted to about 60 cu. ft. In places where the lower bank was of loose soil, 1-in. boards were placed on the sides of the ditch to lessen the tendency to break. Figs. 14-A and 14-B are views taken during the construction of the ditch.

Between the dam and the penstock there are several small streams which flow into the American River from the north bank, but none of these are of material value except Mosquito and Jay Bird Creeks at the lower end. In these two creeks combined there is enough water during the winter months to run the entire plant, so branch flumes with small diverting dams have been

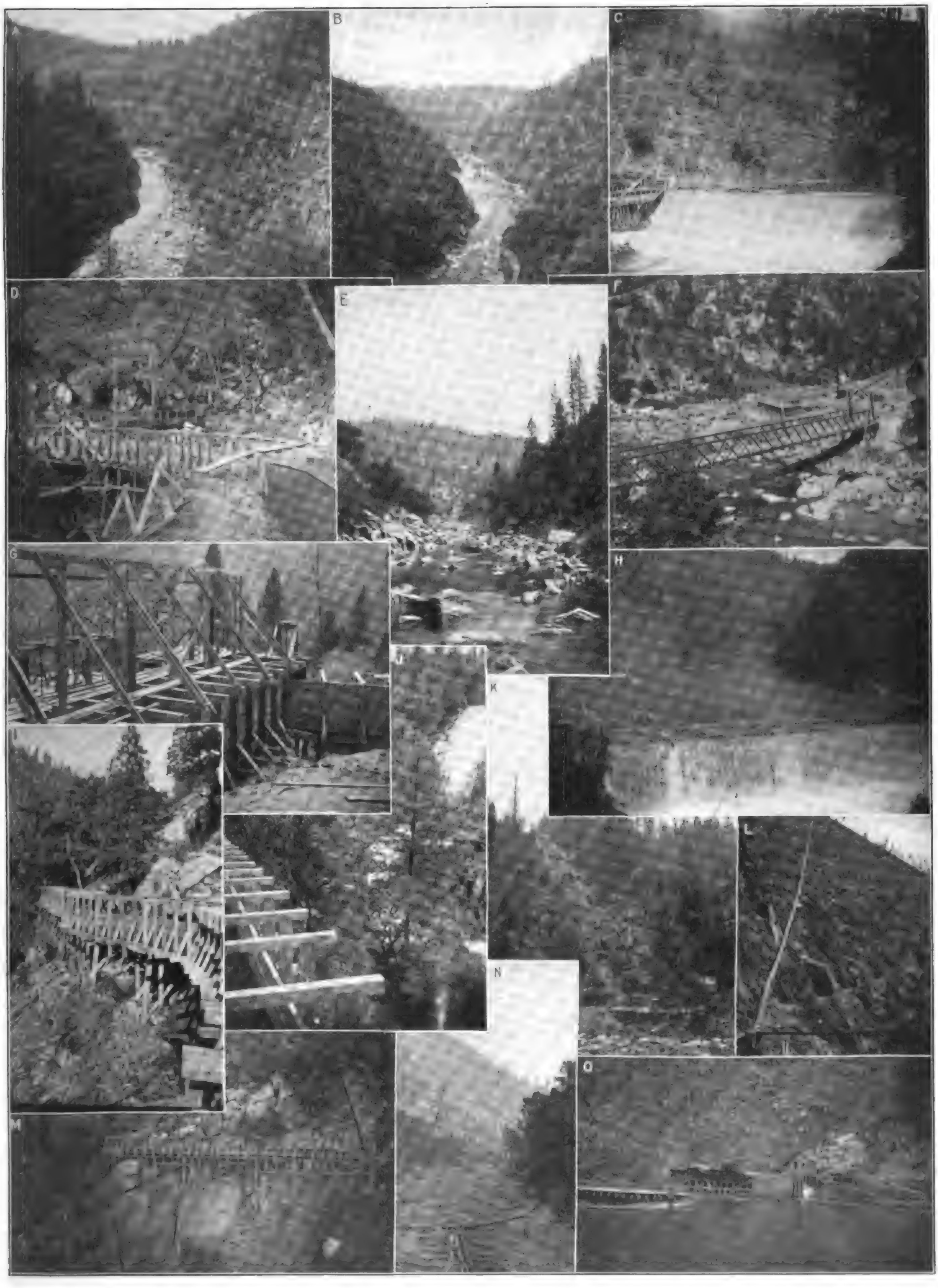

FIG. 6.—TYPICAL SCENES ALONG THE FLUME LINE OF THE AMERICAN RIVER ELECTRIC COMPANY.

A. Looking Down River About Center of Canal. B. American River Showing Flume Line Near Upper End. C. Dam and Headworks. D. Branch Flume and Diverting Dam at Jay Bridge Creek. E. American River at Low Water Stage. F. Bridge and Power House During Construction. G. View of Penstock. H. Dam and Reservoir. I. Typical Flume Section. J. Flume and Tributary Creek with Falls to the Right. K. Transmission Line on Right-of-way Opposite Side of River. L. Lumber Chute. M. Typical Flume Section. N. Lumber Above Dam. O. Headwork.

built in order that these waters may be turned into the main flume if desired. These branch flumes are about 4 ft. x 4 ft. in the clear and are built with a fall of 1 foot in 10. The arrangement at Jay Bird Creek is illustrated in Fig. 6-D, a portion of the main ditch and flume being shown in the foreground. The provision of these two branch flumes makes it possible to shut down the main flume above for repairs or alterations should it become necessary. At convenient points along the main flume are waste gates for controlling the depth of the water. A 12-in. plank on top of the caps affords an easy path for the use of the flume man in patrolling the canal.

In building the flume, water was let into it and lumber floated down from the dam as the construction proceeded down stream, as there were but one or two roads in the vicinity and they would have been of but little assistance. The rough timbers were obtained from a lumbering camp higher up on the river and were delivered by means of a narrow-gauge railroad to a point about half a mile above the dam. Here a wooden chute, 2,400 ft. long and stretching from the top of the bank to the river's edge, was constructed and all the lumber used was dropped down this chute into the river. The velocity acquired by the timbers was frequently sufficient to carry them to the opposite bank of the river. Fig. 6-L is a view of the chute and gives an idea of the operation. After being delivered in the water the lumber was floated down to the dam, where a temporary saw mill was installed to a size and surface. Fig. 6-N shows a part of the lumber above the dam after the

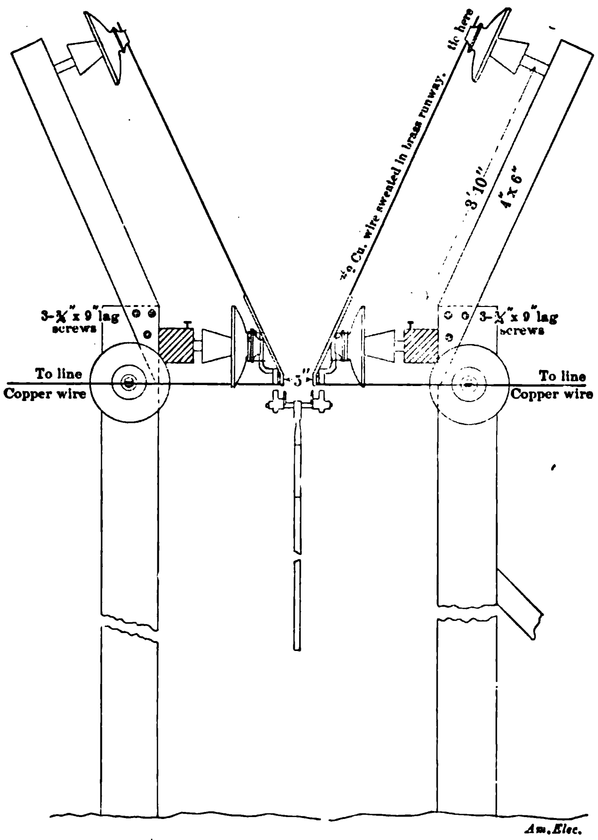

FIG. 7.—ASSEMBLY OF SWITCH.

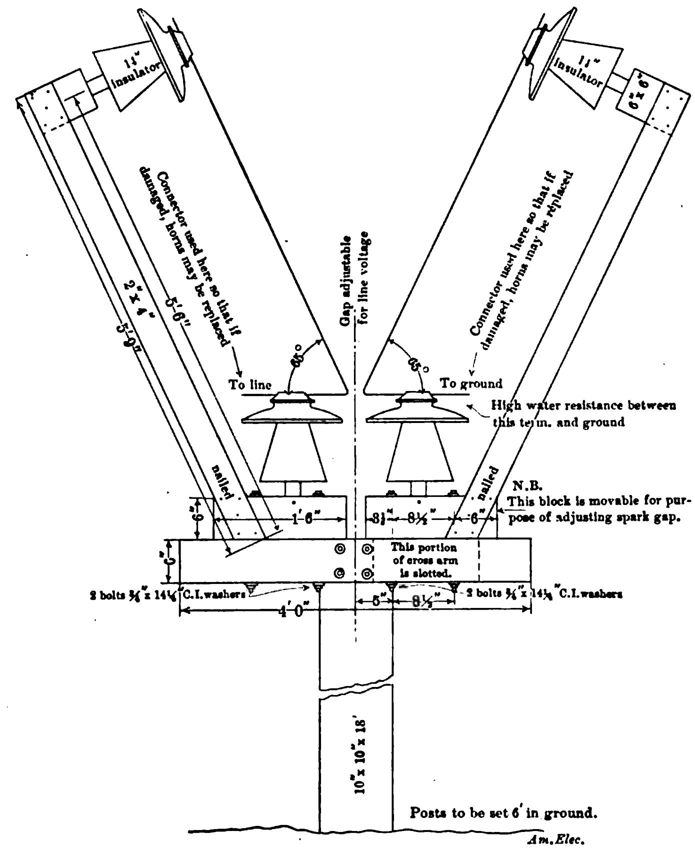

FIG. 8.—DETAILS OF LIGHTNING ARRESTER.

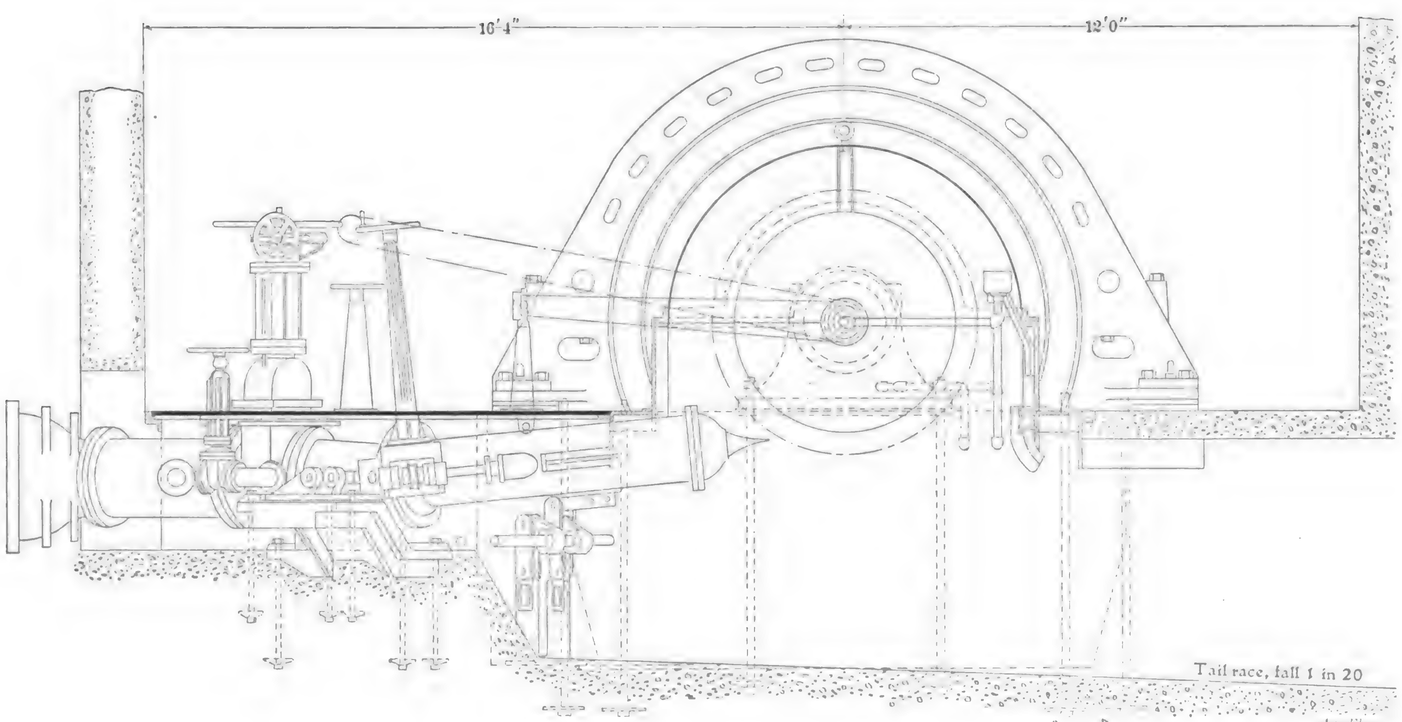

FIG. 9.—ELEVATION OF WATER-WHEEL AND GENERATOR IN POWER HOUSE.

water had been let out of the reservoir. The flume and ditch were built by the San Francisco Construction Company, of San Francisco.

The penstock, Fig. 6-G, is located on the brow of the hill overlooking the junction of Rock Creek with the American River. It is constructed of timber and is 60 feet long. The main flume, 6 feet in height, runs along one side and the water passes through wire screens and wooden gates into the pipe boxes. Each of the two pipe lines is served by three 2 ft. 3 ins. x 4 ft. gates operated by handwheels and rods from the platform above. The waste water is carried off at the end of the penstock through a branch flume to a spillway apron that discharges into Rock Creek and which is large enough to take care of all the water in case of a shutdown. Fig. 5 is a view of the penstock showing gate-gear, etc. There is room for a third pipe line and set of gates when the load on the station demands an addition. The screen is used to collect leaves, twigs and other debris and extends the whole length of the penstock. The screen is double and is made of ½-in. square mesh No. 6 galvanized iron wire. For convenience in handling for cleaning purposes, the screen is mounted on angle-iron frames 3 ft. x 7 ft. in size. The pipe boxes are each 5 ft. wide, 10 ft. long and 12 ft. deep, and the lower part of the outside wall is given a batter to set at right angles to the axis of the outgoing pipe.

From the penstock two pressure pipes 1,614 ft. long and 36 ins. in diameter lead to the power house. The upper portion of the pipe line, as shown in Fig. 14-C, passes over an easy grade so that for a distance of 400 ft. it was possible to use redwood stave pipes as the head developed in that distance was but 120 ft. At the end of the 400 ft. of redwood pipe the riveted sheet-steel pipe construction begins, the thickness increasing with the head. The first 400 ft. is of No. 10 steel and this is followed by 150 ft. of 3-16 in., 150 ft. of ¼ in., and 364 ft. of 7-16 in. pipe, making a total of 1214 ft. of steel pipe. Figs. 14-F and 14-G are views taken during the laying of the steel pipe. The pipes are securely anchored with concrete at the strain points and have air valves to relieve the air pressure in starting up after a pipe has been emptied.

A maximum static head of 575 ft. is obtained from the water level of the penstock to the centre of the nozzles. Just outside the power-house each pipe line branches into a Y, each leg leading to a water wheel.

In addition to the main pressure pipes a small amount of water is diverted from the penstock to a settling tank from which a 2½-in. pipe is carried to the power house. This water, which has a pressure of about 200 pounds, is used for the regulators of the water wheels.

An ingenious device has been installed at the penstock to indicate to the station operator the level of the water. A ball float is connected with a lever so that as it moves up and down with the changes in water level it moves an iron core in and out of a solenoid that is connected in series with an alternating-current ammeter on the switchboard in the power house. The solenoid is specially wound so that the changes in current as produced by the movements of the float can be read off accurately in inches from a special scale on the ammeter.

The power house, Figs. 1 and 2, is located above high-water line on a point of land between the junction of the American River and Rock Creeks. The latter stream sends down a considerable amount of water, which for eight months of the year would be sufficient to operate the entire power plant. The company controls the water right on Rock Creek, and with about six or seven miles of flume and ditch could bring its waters into the same penstock that is now used for the main stream. In time it may prove desirable to have this auxiliary supply. The power house is built of concrete with a steel truss roof covered with slate and is thoroughly fireproof. In this building are located the generator and exciter units and low-tension switchboard, no potentials above 2200 volts being allowed there. A separate building, as will be mentioned later, is provided for the transformers, while the high-tension switching is all done in the open air. Fig. 2 is a general view of the power station building, showing the pipe line at the right.

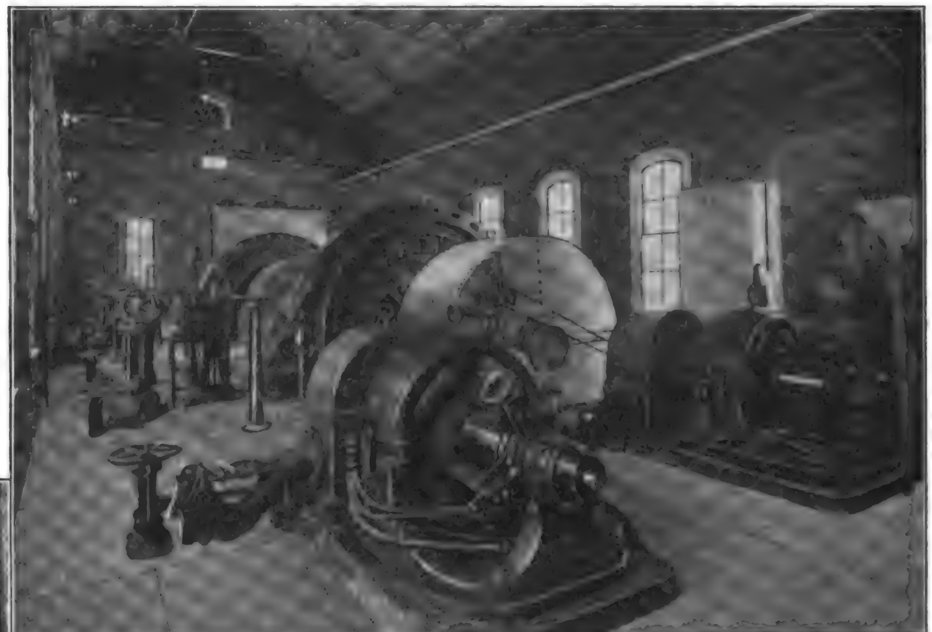

FIG. 11.—INTERIOR OF POWER HOUSE.

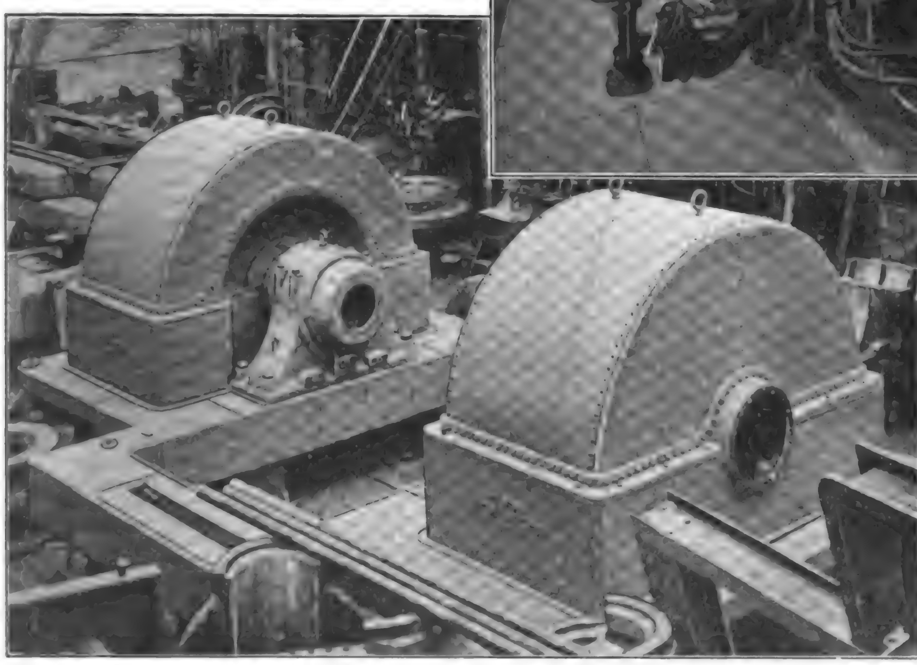

FIG. 10.—SETTING OF WATER WHEELS ON BED PLATE.

The generating equipment consists of two 1500-kw., three-phase, rotating-field, 300-r.p.m., engine-type Westinghouse generators, each being direct driven by the Pelton water wheels being supplied by the branches already mentioned. The rotor of the generator is pressed onto the shaft between the wheels and the shaft is carried in two generator-type, ring-oiling Pelton bearings, the bearing thus being located between each wheel and the rotor. The bearings also have water-cooling compartments, the circulating water used being caught inside the housings in a trough from which the water flows into the compartments by gravity. The whole is mounted on a very substantial cast-iron bed-plate, carrying also the sheet-steel cover housings which suitably enclose the water wheel, pressure pipes, etc.,

within a water-tight chamber. This chamber is entirely open at the bottom into the tail race, which is of massive concrete construction to give solidity to the entire structure. The wheels are constructed of cast-steel plates on which are fitted cast-iron Pelton buckets.

Water is supplied to each wheel through a 7-in. Pelton needle deflecting nozzle, the needle being arranged to regulate the size of the stream, which can be done at any time while the wheels are in operation by the station attendant through the hand wheel and floor stand located near the gate valve. This enables the stream flowing in each wheel-pit to be adjusted for the maximum probable load demand, and automatic regulation is then effected by the governor which raises and lowers the deflecting joint of the nozzle, thus permitting a greater or less quantity of the jet issuing from the nozzle tip to strike the wheels. When the wheels are running at correct speed, the discharge water falls from the buckets without any appreciable energy, and that portion of the stream which may be deflected below the wheel passes clear against suitable steel-lined deflecting plates provided for the purpose. A heavy outside screw and yoke, bronze-mounted gate valve provided with roller bearings is also located back of each nozzle, so that one or both nozzles may be operated at any time. With this arrangement the same high degree of water-wheel efficiency is said to be obtained, down to about 1-10 load, at full load—a very important consideration in most water-wheel plants during low-water season.

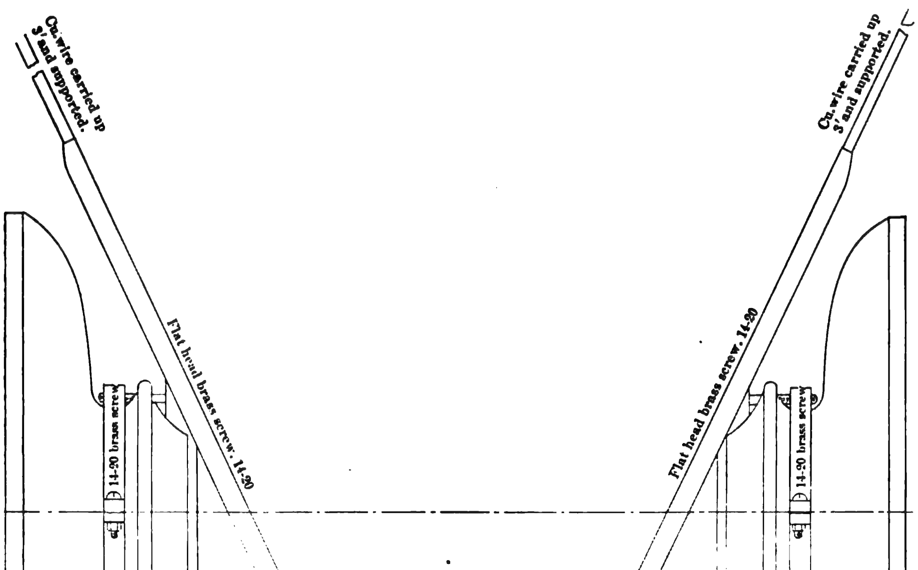

FIG. 12.—ASSEMBLY OF HIGH-TENSION SWITCH.

Automatic governing, as already mentioned, is accomplished through the deflecting of the ball-joint nozzle, which is accomplished through a suitable rock-shaft actuated by a type A Lombard governor. All of the pressure connections are arranged below the floor line, the plant thus presenting a much better appearance and eing susceptible to a much more satisfactory arrangement.

Fig. 10 shows the bed-plate with water-wheel housings and generator-type bearings in position. In one end of each housing and directly opposite the end of the shaft is located a plate-glass covered sight hole from which the operation of the wheel may be observed. Each of the two units has a maximum capacity of 3,000 horsepower.

The exciters are two in number, of 75 kilowatts capacity each, and run at 750 r.p.m. Each is mounted on an independent bed-plate and driven by a special 28-in., 100-h.p. Pelton wheel with bronze buckets to which water is supplied through a needle nozzle and gate valve, similar to that of the large units except that the nozzles are not provided with ball joints. Between the wheels is placed a Type F Lombard governor, arranged so that it can be connected to either unit, as one exciter is sufficient for both generators. Water for the exciter wheels is taken through 5-in. pipes from the large pressure mains, the pipes being connected so that either exciter may be driven from either pipe line. A general view of the generator room is given in Fig. 11.

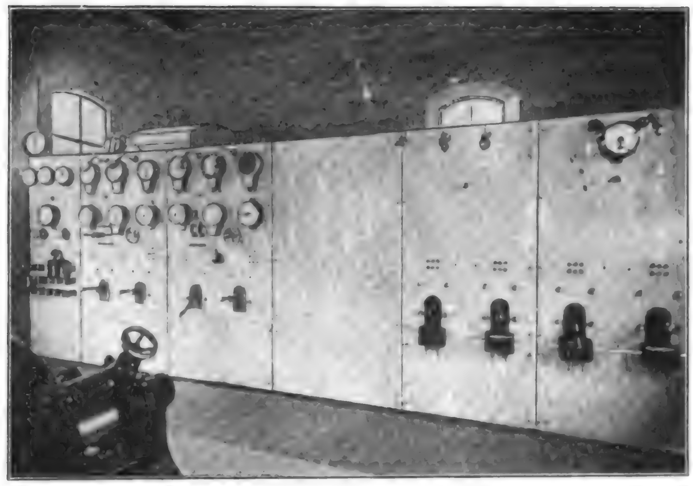

FIG. 13.—SWITCHBOARD IN POWER HOUSE.

The alternators deliver a 2200-volt, 60-cycle, three-phase current and the leads, which are rubber-covered, double-braided, 250,000-circ mil cables, are carried in pairs to the switchboard under the power house floor in 6-in. glazed sewer tile. The switchboard, illustrated in Fig. 13, is built of blue Vermont marble on an angle-iron framework and consists of seven panels 90 inches high. The first panel on the left is used for the exciters and has for its equipment one direct-current voltmeter, two direct-current ammeters, one 5-ampere alternating-current ammeter for use with the water signal for the penstock, two 800-ampere, three-pole, double-throw, quick-break switches, two field rheostats, pilot lamps and plugs for the voltmeters. The next two panels control the 1500-kw. alternators, and the equipment of each consists of three indicating Bristol recording voltmeters, one frequency indicator, one power-factor meter, two 600-ampere single-pole, oil-break switches, one double-throw, two-pole field switch with necessary resistance, synchronizing lamp and voltmeter plugs. The fourth panel is left blank for the addition of a third unit. The next two panels control the circuits leading to the transformers, the equipment of each comprising an 800-ampere, alternating-current ammeter and two 600-ampere, 2200-volt, three-pole, single-throw, Type B interlocking circuit-breakers. On the seventh panel, which controls a 2200-volt circuit running to Placerville, are one triple-pole, double-throw oil switch, three Bristol recording ammeters and one Bristol recording voltmeter.

On a swinging arm at the left end of the switchboard are mounted an indicating voltmeter and a synchroscope. A feature of

FIG. 14.—VIEWS SHOWING DITCHES, PIPE LINES AND FOLSOM MACHINE SHOPS AND SUB-STATION.

A. Digging Ditch. B. Typical Ditch Section. C. Steel Pressure Pipe near Upper End. D. Machine Shops of the Folsom Development Company. E. Folsom Sub-Station with Wires Crossing Over Railroad and Two Other Transmission Lines. F. Steel Pressure Pipe. G. Redwood Pipe at Upper End of Pressure Pipe.

the board is a push-button attachment on each generator panel for controlling the governors. The arrangement consists of a direct-current motor controlled by a reversing push-button switch, one button raising the speed as long as pressed, the other lowering it in a similar manner. The low-tension wires in the building used for lighting are run in flexible iron conduits imbedded in the concrete walls.

The transformer installation as a precaution against fire has been located in a separate building placed about 25 ft. distant from the west end of the main station. This building, as shown in Figs. 1 and 2, is also built of concrete in the same general style as the larger structure. The low-tension, 2200-volt leads are carried from the switchboard in the power house to the transformers in 6-in. glazed sewer tiles.

There are seven transformers installed in the building, one of them being for emergencies. Each transformer is of the oil-insulated, water-cooled type and has a capacity of 625 kilowatts. They are designed for connection in delta on the generator 2300-volt side and for star connection on the primary and are provided with taps so as to give line voltages of 60,000, 50,000, 40,000 or 30,000 volts. With a 100 per cent power factor they are guaranteed to have a regulation of 1.7 per cent, and they will operate continually at full load with a raise in temperature not exceeding 40 degrees above the surrounding atmosphere. For convenience in moving them about, each of the transformers is mounted on a steel truck with cast-iron wheels. In order to guard against damage which might be caused by fire in the transformer house, arrangements have been made for emptying the oil in the transformers quickly. A cement-lined sump or pit is located just outside of the building and is connected by means of a 3-in. wrought-iron pipe with the cases of the transformers. This pit will hold the oil from three transformers. A novel device has been designed for attachment to this outlet pipe which will be automatic in action and will not require any attention in case of fire. The arrangement will comprise a 10-in. drum with a 3-in. face, which will be mounted vertically on an extension of the valve stem. A flexible wire cord will be wound around the drum and then carried over a system of small iron pulleys to the outside of the building, where it will be attached to a piece of iron of sufficient weight to unwind the drum and open the valve when allowed to hang free. Normally this weight will be held up about two feet by a hemp cord which will pass into the building and over the transformer case. In case of fire endangering a transformer the cord is burned through, allowing the weight to fall and unwind the drum, thus opening the valve and allowing the oil to run into the sump outside.

The high-tension wires leave the transformer house through 24-in. glazed sewer tiles set at an angle in the end of the building facing the river. From the transformer taps to these large conduits the wires are run on 14-in. porcelain Locke insulators carried on 6-in. x 8-in. timbers running across the house.

The high-tension switching apparatus, as well as the lightning arresters, is installed in the open air in front of the transformer house, being mounted on poles and timbers erected for that purpose.

Leaving the transformer house, the six high-tension wires which comprise the two main transmission circuits first pass through choke coils mounted on a framework on a level with the sewer-pipe conduits. Each of these choke coils is constructed of 24 turns of No. 2 B. & S. gauge hard-drawn copper wire slipped over a length of glazed sewer tile. The coils are about 8 ins. in diameter and the turns are spaced about an inch apart. The whole arrangement is supported by two Locke insulators. This device is simple and inexpensive and has served the purpose very well.

Although there is comparatively little lightning in that section it was deemed advisable to install arresters, the horn type being adopted. The design of this arrester is shown in Fig. 8. It consists of the line wire and ground wire terminals being mounted on four 14-in. Locke insulators as shown, with 5 ft. 9 in. arms, the whole being mounted on the top of an 18 ft. 10 in. x 10 in. timber. The spark gap is arranged so that it can be adjusted for the line voltage by moving the grounded side of the horn back and forth on its cross-arm support, it being secured by two bolts which slide in a slot when loosened. Between the ground side of the horn and the ground a high resistance is used in the shape of a 25-gallon glazed earthen jar filled with water and supported on an insulated platform.

The high-tension switch used on each phase of the circuit is of the fused type with horns for dissipating the arc when the fuse is blown or the switch is pulled. Fig. 12 is a detail of the working parts of the switch. The two knife edges are supported at the ends of a 1-in. glass tube which has at its center a brass attachment that fits into a bayonet socket on the end of the switch handle. The points of the knife edges are connected by the fuse. Each side of the stationary part of the switch consists of brass clips fastened on a curved piece to a standard 14-in. Locke insulator by means of screws and stud to a clamp surrounding the neck of the insulator. The main leads are sweated into the ends of the brass runways at the bottom and carried up a distance of three feet to form the horn. The switches are mounted on a framework with 6-ft. centres and 18 ft. above the ground.

Special precautions have been taken to guard the attendant against accident when operating the switches.. He stands on a platform supported on six Locke insulators and uses a specially constructed handle. This handle is six feet long and has at its upper end the bayonet socket which makes connection with the attachment on the glass rod supporting the switch knife edges. Between the socket and handle grasp is 4½ ft. of 1½-in. round maple treated with a weather-proof varnish. The handle-grasp is made of a piece of heavy glass tubing, 1½ ins. outside diameter, slipped over and firmly glued to a projection of the wooden portion. Covering the glass is a section of the best quality rubber hose, the ends being securely sealed with an insulating compound. At the upper end of the handle-grasp is a shield to keep the attendant from coming in contact with the wooden portion of the handle. The shield consists of a circular piece of plate glass 4½ inches in diameter, with a ⅜-in. hole in the centre that fits over the pole. Above the glass is a fibre washer to protect it from breakage.

The transmission system consists of a double high-tension pole line from the power house to Placerville, where the lines separate, one being carried in a southern and southwestern direction to Stockton, 80 miles distant, while the other is carried nearly west to the vicinity of Folsom, a distance of 30 miles. At present power is being transmitted at 35,000 volts, but the lines are built to carry 60,000 volts and can be operated at that voltage when desired. The present load on the station is about 2000 horse-power. From the power house a low-tension, 2300-volt circuit is carried direct to Placerville, where it is used to supply about 2000 lights. Fig. 6-K shows the three circuits as they leave the power house and are carried across the river on 250-ft. spans and up the bank on the opposite side. The poles used are of seasoned round cedar and vary in length from 35 to 65 feet, according to the lay of the ground. The butts of all poles are treated with a coating of carbolinium avenarius as a precaution against decay. On the double pole line the poles are spaced 180 feet apart and the two lines are separated 25 feet from each other. The cross-arms are of Oregon pine 4¾ ins. x 5¾ ins. and 7 ft. long, and carry two 14-in. Locke No. 320 insulators. The third wire is supported on an insulator of the same size mounted on the top of the pole. The wires are spaced 72 inches from each other on an equilateral triangle. On the double line from the power house to Placerville cross-beams of Oregon pine, 4 ins. x 8 ins., span opposite poles below the cross-arms and carry the three wires of the 2300-volt Placerville circuit and two telephone circuits. After the high-tension lines branch each telephone circuit is carried on a separate cross-arm below the main cross-arm. The pins used are of eucalyptus and are 17 ins. in length for the cross-arm and 19 ins. for the top. As there is a tendency for the pole to split at the top on account of being bored for the pin, the pole-top is wound with eight turns of No. 10 galvanized iron wire. A novel feature has been introduced for the protection of the wooden pins against leakage or static discharge by wrapping the entire length of the exposed portion of the pin in sheet zinc. The additional cost of the zinc is less than three cents per pin and the higher cost of iron pins that are being quite generally recommended is saved. Thus far the results from this construction have been very satisfactory, not a single pin having been lost. In this connection it is very interesting to

notice the exhibit shown in Fig. 18. This shows a pole-top that had been burned away and the insulator and pin. When the pole was found it had been burned as shown, but the insulator and pin were still in position, being held there evidently by the winding of galvanized wire, while the zinc wrapping had protected the pin and thus kept the insulator from falling. The lesson to be drawn from this exhibit is obvious. The entire line to Stockton consists of No. 1 B. & S. gauge seven-strand bare aluminum wire, weight 401 pounds to the mile. Soft aluminum wire is used for the wires and the poles are set 180 ft. apart. For the Folsom line No. 4 medium hard-drawn copper wire has been used with No. 6 annealed copper tie wires. On account of the greater weight of the wire the poles on this line are set 135 ft. apart. The company installed both aluminum and copper lines so that it could observe the working results of both under similar conditions and determine which was the best material to use for future extensions. Thus far the wires have not been in operation long enough to give conclusive results.

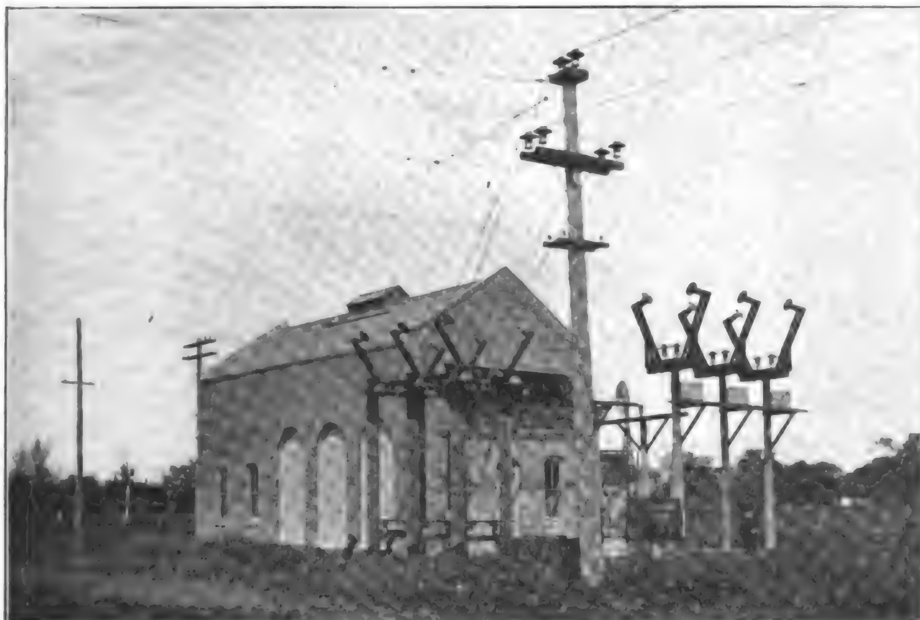

FIG. 15.—STOCKTON SUB-STATION.

FIG. 16.—JENNY LIND SUB-STATION.

FIG. 17.—HIGH-TENSION END OF FOLSOM SUB-STATION.

Fig. 14-E is a view of the company's Folsom sub-station and shows how the 11,000-volt and 2200-volt secondary wires are carried up and over a steam railroad track and two pole lines of another transmission company. The poles are of sufficient height and close enough together so that a broken wire will not come in contact with a train, and further protection is provided by a wire net between the poles and above the track.

At the Stockton terminus of the 80-mile, high-tension transmission is the neat brick sub-station shown in Fig. 15. This view also illustrates the high-tension switching apparatus and lightning arresters, which are of the same types as those shown at the power house. The sub-station is equipped with step-down transformers and as a rule does not require an attendant. There are installed in the station three 150-kw. and three 300-kw., oil-insulated, water-cooled transformers. These transformers are constructed with taps for 30,000 to 60,000 volts on the primary and 2200 volts on the secondary, with an allowable variation of 5 per cent above or below. The switchboard, Fig. 20, has three panels—one for the transformer and two for the secondary feeders, equipped with oil switches, lightning arresters, instruments, etc.

In Stockton the company supplies a commercial service of about 6000 incandescent lights and about 300-horse-power in motors. It has only been operating since early in 1904, and is competing with an old-established company. In the business district of the city the company is placing its commercial three-wire, 220-volt secondaries underground in Edison tubing.

A feature of the sub-station, as well as of the power-house, is the precaution taken in installing the telephone instruments. In Fig. 19 is shown the apparatus in the Stockton station. The telephone is mounted on the upright portion of a platform which is insulated from the concrete floor by glass insulators. A person talking has to stand on this platform in order to reach the instrument. The two line wires terminate above the telephone, as shown, in special fuses mounted on slate panels that are in turn insulated from the wall. A knife switch with a long break is placed above each fuse so that the line can be cut out when the fuse is replaced. The telephone line from the power house passes through this sub-station and then to the company's office in the city and the wiring is arranged so that the talking circuit may be cut out when no one is at the station. Knife switches are provided for cutting the talking circuit in and for cutting out either the power house or the office end of the line. No trouble is had in talking over the 80-mile circuit to the power house or over the entire 110 miles to Folsom. In the power house a special concrete booth has been built for the telephone and the latter is also insulated in the same manner as at the Stockton sub-station.

At various points along the Stockton transmission line the company has been able to develop a good business in the supplying of power. This line runs through some of the richest mining camps in the Mother Lode and the outlook for further development is very good. An electric railway is to be built from Ione to Jackson and Sutter

Creek and the American River Electric Company has the contract for supplying the necessary power.

A spur of the line runs to the Jenny Lind mining section, where the sub-station shown in Fig. 16 has been erected to take care of the business. The equipment consists of three 100-kw. transformers which reduce the voltage to 2200 or 4400 volts, the latter being used. The power supplied from this station is utilized for the operation of gold dredging plants. At Nashville a similar sub-station has been installed, the power in that case being used for quartz mining.

FIG. 18.—BURNED POLE TOP.

The Folsom sub-station, at which the 30-mile, high-tension line terminates, is constructed of corrugated iron and covered with P. & B. roofing. The interior of the sub-station is shown in Fig. 21. The equipment consists of four (one spare) 300-kw. transformers stepping-down from 30,000 to 2,200 or 4,400 volts and three 100-kw. transformers stepping-down to 11,000 volts. The entire output of this station is sold to the Folsom Development Company, a corporation which has entered extensively and systematically into the gold dredging business in that vicinity. This company has purchased 18,000 acres of land in that section; has two dredges in operation near Folsom; is operating two or three at a point four miles below, and is planning to build ten or a dozen more in the near future. As this phase of electric power development is an interesting one, some mention will be paid to it.

In Figs. 22 and 23 are shown two of the Folsom Development Company's dredgers at work. These dredgers are built on the spot, a pit being excavated for the purpose, and if the land is not near enough to the river to give water to float the boat, water is pumped into the pit. The gold-bearing soil is a gravel deposit that has been washed down in old river channels from the rich Mother Lode district farther up on the mountains. It has only been since electric power could be obtained at a cheap rate that it has been profitable to work this ground, but judging from the investments that are being made now by this and other companies in the way of expensive machinery installations, the business must be a decidedly profitable one. The mining has been reduced almost to a science so that there is little if any chance in the work. The entire land is surveyed and divided into plots 50 ft. square and in the center of each plot a prospect is drilled by sinking a 6-in. shaft to hard pan. All the gravel and sand that is removed is carefully measured and its gold-bearing properties determined. If it is found that the percentage of gold is high enough to make dredging profitable the plot is reserved for working. Then, as mentioned before, a large pit is dug and the dredger built complete on the spot. Both dredgers illustrated in Figs. 22 and 23 are of the type constructed by the Bucyrus Co., of Milwaukee, but the engineers of the Folsom Development Company, who have been working on the problem for several years, have designed a dredge which is said to suit the local conditions better and hereafter the company will build all this machinery in its own shops and construct the dredgers complete. The gold-bearing strata varies from 10 to 50 ft. in depth and the boats are designed to work to those depths. The earth is picked up by chain buckets, each bucket having a capacity of 5 cu. ft. The dredgers are generally rated by the capacity of the buckets, and a 5-ft. bucket dredger will dig from 50,000 to 75,000 cu. yds. of material per month. The earth is raised by the buckets and deposited in a shaker or screening device which shakes the rocks loose from the dirt and small gravel. The rocks are deposited on an endless conveyor belt which delivers them at some distance behind the dredger on ground that has been worked. The soil is washed through shakers and riffles, the gold being deposited on saving tables, while the sand is forced out at the rear through a pipe by means of a centrifugal pump.

In dredger No. 2 of the Folsom Co., illustrated in Fig. 23, a 100-h.p., variable-speed, induction motor is used to drive by means of a large belt the digging buckets and the drum for raising and lowering the buckets. A 50-h.p., 2200-volt motor is direct connected to the shafts of two Goth centrifugal pumps which are used for pumping water onto the riffles and shakers for washing the earth. On the deck of the dredger is a 30-h.p., 440-volt motor which drives the shaker and also operates the large rubber rock conveyor belt that is seen extending in the rear of the boat. A 20-h.p., 440-volt, variable-speed motor is used for driving the winches with which the boat is moved from one position to another and which are also used for raising the spuds.

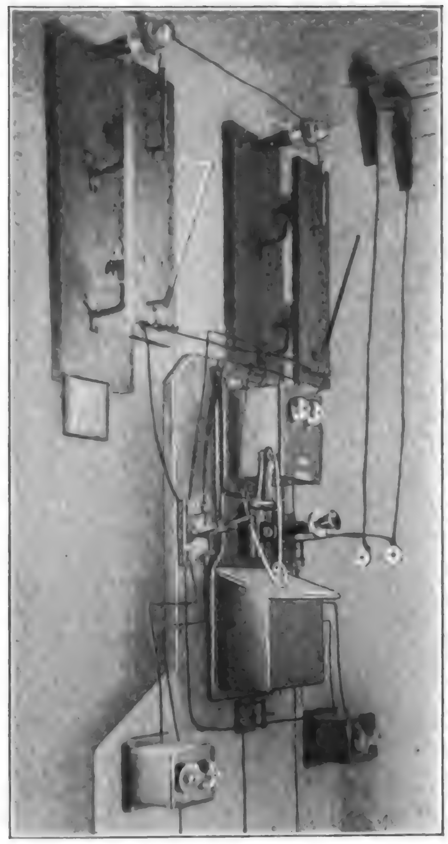

FIG. 19.—PROTECTED TELEPHONE IN STOCKTON SUB-STATION.

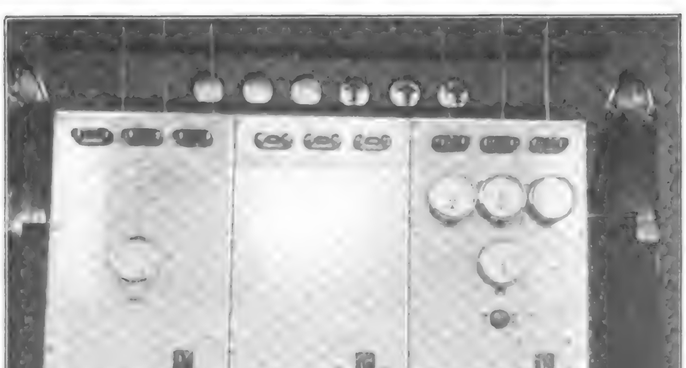

FIG. 20.—SWITCHBOARD IN STOCKTON SUB-STATION.

FIG. 21.—INTERIOR OF FOLSOM SUB-STATION.

There are two of these spuds at the rear corners of the boat and they are used to hold the dredger in position while it is operating. One spud is built of steel 50 ft. long and weighs about eighteen tons, and the other is of wood and weighs about ten tons. A 30-h.p., 440-volt motor is connected to a centrifugal pump which is used to force the sand discharged from the screws through the pipe on the conveyor ladder. There is a 3-h.p. motor that drives a centrifugal pump used in priming the large pump used for washing the decks and similar purposes. This equipment of six motors, aggregating 233 horsepower, is controlled and operated from a controller or switch room located at one corner of the upper deck. The buckets and winches are operated from this room by means of levers and a specially wound controller. A lighting switchboard located there controls the 125 16-c.p. incandescent lights that are used to illuminate the boat and surroundings at night, as the dredging work is carried on night and day. Five-lamp clusters are used with reflectors for the exterior lighting. Arc lamps of ordinary construction cannot be used on the dredgers on account of the constant vibration of the boat.

The present accepted construction of the dredgers call for the location of the transformers on the boat, but on account of the insurance regulations a special sheet-iron-lined compartment is built on the outside of the boat to contain them. The transformer room on No. 2 dredger contains three 30-kw. Westinghouse transformers which reduce the voltage from 2200 to 440 volts. All the motors on this boat are of General Electric manufacture. Dredge No. 1, illustrated in Fig. 22 has equipment similar to that of No. 2, with the addition of a 10-h.p. motor driving a centrifugal pump for discharging water into the hopper into which the buckets empty.

A very important feature of the electrical operation of the dredgers is the cable which is used to transmit the power from the end of the pole line to the bank of transformers on the boat. After a good deal of experimenting with various kinds, the electrical department of the company has adopted a standard cable which consists of three No. 2 double rubber-covered 3/32-in. insulation wires pulled into a 1¼-in. heavy rubber hose. The joints of the hose are carefully cemented and the cable is then tested to 10,000 volts. This cable has proved very satisfactory, and although generally supported above the water by barrels it can be safely used under water. The extent to which the Folsom Development Company is carrying on its dredging work has warranted it in erecting a large machine shop, offices, etc., on the ground, a general view of which is shown in Fig. 14-D. At these shops everything in the way of machine work for new dredgers as well as repairs on those in operation is being caried on, the foundry work being done in Sacramento. The machine shop is well equipped with heavy tools and is operated electrically, seven motors ranging from 3 to 30 horsepower being used for the purpose. A portion of the shop is also fitted up for electrical repair work. All the electrical work of the company, including that on the dredgers and in the shops, is in direct charge of Mr. A. B. Coon, electrical engineer of the company.

FIG. 24.—PORTABLE SUB-STATION AT FOLSOM.

An allied corporation has in operation near Folsom a dredge in connection with which is used the unique portable sub-station illustrated in Fig. 24. This transformer house is mounted on a street-car truck and is moved around on a temporary track as frequently as is necessary. The building contains three 50-kw. Westinghouse transformers delta connected. They reduce the voltage from 11,000 to 1200 volts. The high-tension fuses and a set of Westinghouse low-equivalent lightning arresters can be seen in the opened compartments at the end of the station. The current is carried from this sub-station to the dredger at 1200 volts in a flexible waterproof cable which contains three conductors. The dredge is a typical New Zealand gold dredge electrically operated. The boat was built by the Risdon Iron Works, of San Francisco, and placed in operation about two years ago. The largest motor on the boat is a 75-h.p. type F Westinghouse variable-speed induction motor which drives the digging buckets. The pump which supplies the water for washing the gravel is driven by a 50-h.p. Westinghouse type C constant-speed motor. These two motors are operated at 1200 volts. The smaller motors on the boat are one 20-h.p., constant-speed machine driving the conveyor, two variable-speed motors operating the two winches and one 1-h.p. motor driving a small pump for

FIG. 22.—DREDGE NO. I. OF THE FOLSOM DEVELOPMENT COMPANY.

FIG. 23.—DREDGE NO. 2 OF THE FOLSOM DEVELOPMENT COMPANY.

fire purposes and for priming the large pumps. The small motors are operated at 440 volts. A bank of three 25-kw. Westinghouse type O. D. transformers are used on the boat for reducing the voltage from 1200 to 440 volts and also to 110 volts for lighting purposes. About 75 incandescents are employed for lighting on the boat. The capacity of the buckets on this dredge is five cu. ft. each and about fourteen buckets are dumped per minute. This boat has been in almost constant operation since being placed in commission two years ago.

The Folsom Company has in connection with its plant a portable compressor plant, consisting of a 10-h.p., 440-volt motor belted to a compressor. This outfit is enclosed and mounted on a wagon so that it can be readily hauled to any desired spot and used for drilling, repair work, etc.

In addition to the extensive field for power furnished by the gold dredging and mining companies, the American River Electric Company expects to develop a good business in irrigation pumping. Its lines tap a rich agricultural section where water can be easily obtained at a depth of about twenty feet, and with cheap electric power there is every reason to expect that the development along this line will be profitable to the company as well as the farmer.

Credit for the design and erection of the American River Electric Company's plant is due to Mr. A. M. Hunt, of San Francisco, recently of the Engineering Offices and also recent general manager of the Independent Electric Light & Power Company of that city. The original features of the system that have been mentioned are practically of Mr. Hunt's design. The entire plant was erected and put in successful operation in about six months, which is an exceptionally short time when the engineering and practical difficulties are considered. Mr. Hunt received very valuable assistance from Mr. B. C. Condit who had active charge of the construction of the plant and is now directing the further operation and development of the system, through his position as superintendent of the American River Electric Company. Appreciation is due both of these gentlemen, as well as to Mr. Mortimer Fleishhacker, of San Francisco, the president of the company, for their courtesy and kindness in assisting the writer in the preparation of the foregoing description.

Municipal Ownership in Great Britain.—A report from the United States Consul at Liverpool states that there is in Great Britain an unmistakable diminution of the tendency toward the municipal ownership of industries. Very little is heard now of new movements in that direction, and the thoughts of the municipalities are more directed toward increasing economy of management of the public utilities which have been acquired. Probably the reaction against municipal ownership may be largely due to the increase of $1,252,000,000 in local indebtedness in Great Britain in 28 years, and the fact that the returns from the whole mass of municipal investment have not been anything like as high as was expected.

REVISION OF THE NATIONAL ELECTRIC CODE.

At the annual meeting of the Electrical Committee of the Underwriters' National Electric Association, held in New York December 7 and 8, the Code of Rules and Requirements for the installation of electric wiring and apparatus was revised in several important particulars and a good many minor changes were made. The most radical suggestions for amendments—those which had aroused the central station men and contractors to a mental state approaching indignant resentment—were rejected with scant discussion and by unanimous vote.

The report of the committee on car wiring was accepted; this recommended that all proposed amendments to the rules on this subject be referred to the Joint Conference Committee for consideration, and that no material change be made in Rule 32 until at least one year has elapsed and the rule has had a fair trial.

The reports of the Committee on Switches and Cut-Outs and the Committee on Test Specifications for Rubber-Covered Wires were also accepted. The Switch and Cut-Out Committee recommended raising the melting point of enclosed fuses to 25 per cent. above the continuous carrying capacity; also the amendment of Rule 1 by adding a section requiring terminal blocks on all electrical machines to be made of approved fire-proof insulating material, such as slate, porcelain or marble.

The Committee on Rubber-Covered Wires recommended that the rules be amended to require each foot of the rubber covering to withstand for five minutes the application of an e.m.f. proportional to the two-thirds power of the thickness of the insulation for coverings of 1/16 inch and over; below 1/16 inch, empirical test voltages of 3000 volts per 1/64 inch are specified.

The report of the Underwriters' Laboratories, recommending no change in present requirements for insulating joints, was adopted, but their suggestion for the omission of insulating joints on grounded systems was referred to a special committee for consideration, on the motion of Mr. Arthur Williams of the New York Edison Company.

The rule regarding leads from central station generators to switchboards was amended by adding a fine-print note to the effect that such leads may be put in a conduit, a smooth runway being desirable, but that lead-covered cable may be used without any conduit if the lead sheath be not allowed in contact with any object tending to abrade it.

A suggestion for an amendment requiring the casings of all transformers in central and sub-stations to be grounded with conductors equal in carrying capacity to the largest fuse in the high-optential circuit was regarded favorably by the committee, but upon explanation by Mr. Alex. Dow, of Detroit, that in many cases there were no fuses in the high-potential circuit and the rule would, in those cases, be abortive the suggestion was referred to a special committee for consideration.

The agitation concerning stringent rules for aerial conductors came to naught. Two definite suggestions were offered: one for a rule requiring conductors "attached to or in close proximity to buildings" not to be installed "so as to interfere with the work of the fire department"; the other for a rule prohibiting the placing of telegraph, telephone and similar wires on the same poles with electric light or power wires, and the stringing of such wires so as to pass above or below heavy-current wires except where accidental contact is prevented by means of suspension or screening wires, as already provided in the Code. These suggestions were promptly rejected.

The rule regarding the entrance of low-potential circuits into buildings was amended to allow such service wires to be brought in through a single iron conduit, the outer end of which must be carried downward and sealed to prevent the entrance of moisture. The outer end must also be kept at least 12 inches from frame buildings or frame portions of other buildings.

The rule on wooden molding was amended to specify a tongue not less than ½ inch thick between the conductors, and exterior walls not less than ⅜ inch thick under the grooves and ¼ inch thick at the sides.

The following are among the minor changes adopted:

Transformers must not be mounted on frame buildings or frame portions of other buildings.

Double-throw knife switches may be mounted to throw either horizontally or vertically, as preferred.

Wires run in unfinished attics are to be classed as "concealed" and those run near water tanks or pipes are considered as exposed to moisture. Wires in attics, excepting in large churches or similar buildings, must be run between or through the joists and not on top of them.

On switchboards, spacings approved for 250 volts direct current are also approved for 500 volts alternating (instead of 440, as before).

The rule on arc lamp hanger boards is restricted to series arc lamps.

No Municipal Plant for Milwaukee.—The faction favoring a municipal lighting plant for the city has again lost in a vote before the City Council. Since the first defeat of the measure in the council, about a month ago, the question has been the occasion of several mass meetings and much heated discussion. One councilman, in order to obtain the opinion of his constituents, mailed to each of them a reply postal card. After the defeat of the measure for the issue of $150,000 bonds for the lighting plant, President John I. Beggs, of the Milwaukee Electric Railway & Light Company, offered to light the city at a rate equal to that which it is figured it costs the city of Detroit for lighting by means of its municipal plant. This communication was referred to the Committee on Street Lights and Judiciary.

P PE JOINTS, GASKETS AND LEAKS.

BY R. T. STROHM.

A leaky joint in a steam pipe may be the cause of a considerable loss during a year of continuous operation of a steam plant. More than this, such a leak never grows less when left to itself. Steam, under high pressure, containing entrained

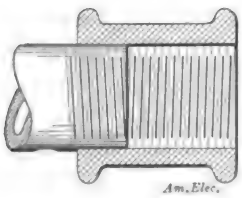

FIG. 1.

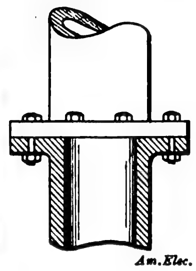

FIG. 2.

moisture, has an erosive effect when escaping from an orifice, which tends to increase the size of the opening. A 1/8-inch hole in a main carrying 125 pounds steam pressure will permit the escape of 88 pounds of steam in an hour. This would be equivalent to 2100 pounds per day of 24 hours. Assuming that it requires a pound of coal to evaporate 7 pounds of water, and that the plant is operated 300 days per year, the effect of the leak is to throw away 45 tons of coal a year.

But this is not the only drawback. To the casual observer, a hissing leak in a steam pipe gives the impression of carelessness or inability on the part of the engineer. Such a verdict may be extremely unjust. All other appliances in the plant may be in practically perfect condition, and the general appearance may be exceedingly neat and trim. Yet the leaking joint will spoil the effect of the whole. Perhaps the leak has just shown itself, and there has been no time, in the press of more urgent affairs, to care for the matter. Or, perhaps, it is not easily accessible, so that its repair must wait a convenient time.

There is still another consideration. All well-regulated plants have their steam pipes protected by non-conducting coverings, to prevent loss of heat by convection and radiation. Most of these coverings are made of asbestos and magnesia, in varying proportions. Hence, when a leak occurs, the condensation resulting from the escaping steam may saturate the covering, rendering it soggy and of little value as an insulator.

Tight joints may be secured in a number of ways, but they always depend upon the materials and the workmanship. A poor workman may fail to secure a tight joint with the very best materials at hand, while a skilled engineer may succeed with a poor quality of materials.

The most common form of joint is the screwed joint, like that shown in Fig. 1. Owing to continued use, the steam fitter's pipe dies may become worn and broken, so as to cut an imperfect thread. Then, when the pipe is put together, a leak develops at the imperfect joint. Or, perhaps, the thread may be cut crooked, because of carelessness or ignorance on the part of the workman, which would likewise result in a leak. The presence of dirt on the threads, preventing their coming into perfect contact, is liable to develop a leak. Hence, to make a good joint, the threads must be cut accurately and be wiped clean before screwing together.

In order to make certain that no leaks should occur, even if the joint was somewhat imperfect, it used to be the general practice to give the threaded portion of the pipe a coat of white lead or red lead. This mixture filled all the interstices between the threads and hardened effectually preventing the escape of any fluids conveyed through the pipe. But this is no longer considered good practice. For, while the joint thus formed was permanent, it would not allow the pipes to be taken apart readily, when such procedure became necessary. The lead on the threads seemed to cement them together, and after the joint had stood for some time it was practically impossible to unscrew the pipes. Frequently the pipe would split and crush under the torsional stress of the wrench without beginning to loosen the joint. In many instances it was found necessary to smash the fittings in order to take down several lengths of the pipe which had been put up with red lead joints. This is no longer necessary. If a

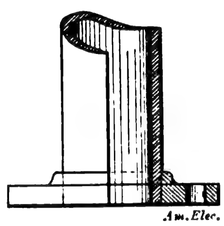

FIG. 3.

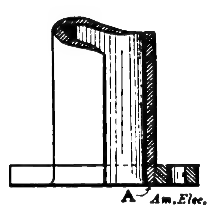

FIG. 4.

good grade of cylinder oil is mixed with graphite until a fairly thick paste is formed, and the threads are coated with this paste, the joint will not only remain tight, but it can be readily taken apart, whenever necessary, without undue labor or damage to the fittings. A low-grade cylinder oil, or a light lubricating oil should not be used in making this paste, because it will carbonize, especially if the steam pressure in the pipe is high, and cause the joint to seize as in the case of the red lead.

Another very common kind of joint is the flange joint, consisting of two flanges held together by bolts, as in Fig. 2. There is a variety of methods by which the pipe may be secured to the flange, depending upon the material and the service to which it is to be put. In the case of cast-iron pipe, the flange is cast in one piece with the pipe, as in the sectional view, Fig. 2. However, it is also common to find cast-iron flanges fitted to wrought-iron pipes by means of a screwed joint as shown in Fig. 3. This is a form much used for comparatively small pipes. A stronger form is illustrated in Fig. 4. Here, a wrought-iron or steel flange is used, and after the pipe is screwed in, its end is riveted over as at *A*, which not only makes a tight joint, but also renders the pipe less liable to fail by stripping off the flange. For large pipes and high steam pressures, the flange is frequently secured to the pipe by riveting, as in Fig. 5, both the flange and the pipe being either of wrought-iron or steel. The end of the pipe is also peened over so as to secure tightness of the joint.

As a usual thing, the faces of the flanges which come together to form the joint are not smooth, and if put together in this condition, a tight joint could not be obtained. Hence, in cases of this kind, gaskets of some yielding material, softer than the metal flanges, are placed between the latter. When the bolts are tightened and the flanges drawn together, this softer material is compressed and crushed, conforming itself to the inequalities of the two surfaces and forming a bond between them which prevents leakage.

Sheet rubber is very extensively used as a material for gaskets. The shape of the gasket is scribed on the surface of the rubber, after which it is readily cut out with a sharp knife. Some engineers use a special form of cutter for cutting out circular gaskets. It consists of a tram having a pivot point and two movable knives which can be set at any desired distance from each other as from the pivot. The distance between the knives determines the width of the gasket, and the distance from the pivot to the nearest knife determines the size of hole in the gasket. Since gasket rubber is sold in rectangular sheets, there is some unavoidable waste in cutting circular gaskets. However, this may be greatly lessened by proper care. The odd corners which are left over will furnish small gaskets for pipe unions, and the circular pieces cut from the centers of large gaskets may be used to give smaller ones for smaller flanges. It will be found that wetting the knife makes the cutting much easier.

On a steam line which carries a lowered pressure during the night, or on any line in which the steam pressure varies, the gaskets are subjected to alternate heating and cooling. The expansion and contraction of the pipe sections twist and strain the joints, and tend to open them. Hence, it is not surprising that joints eventually begin to leak. The heat causes the rubber to harden, and the straining of the joints cracks it, resulting in leakage. The best makes of sheet rubber for gaskets are those

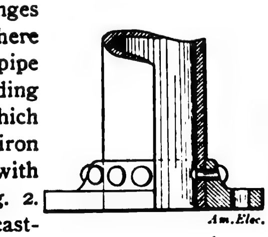

FIG. 5.

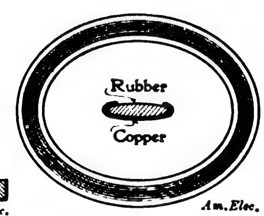

FIG. 6.

which do not lose their elasticity readily and are not easily affected by changes of temperature.

The fact that soft rubber is affected by heat has led to the use of other materials for gaskets, or combinations of other materials with rubber. One form is illustrated in Fig. 6. It consists of a circular rubber ring encased in a shell of soft, annealed copper. Both are easily compressed and conform to the surfaces of the flanges, while

the elasticity of the combination is a point much in its favor. The copper casing adds greatly to its strength, also, making it less liable to blow out under high pressures. This gasket is placed inside the bolt circle.

The ability of asbestos to resist the action of heat has led to its adoption as a gasket material. Being of a fibrous nature it is woven into sheets from which the gaskets are cut, ready to use. For pipe lines conveying high-pressure or superheated steam, the asbestos gasket gives excellent service,

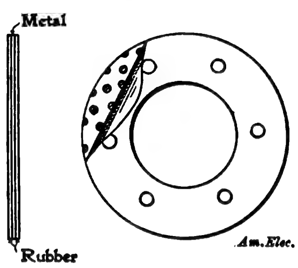

FIG. 7.

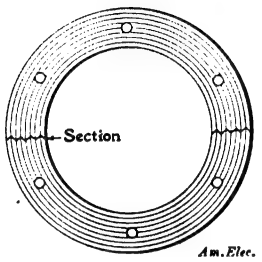

FIG. 8.

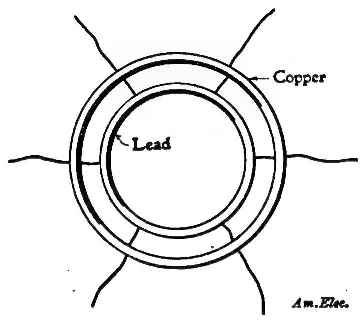

FIG. 9.

and there are instances on record where it has been in use for four years without a sign of leakage.

In some of the sheet packings an insertion of cloth between the layers of rubber is employed to give additional strength. In others, a sheet of soft metal, perforated with numerous small holes, is used instead of the cloth. A gasket with perforated metal insertion is shown in Fig. 7. For extremely high pressures, however, metallic gaskets should be used. One form, composed wholly of metal, is illustrated by Fig. 8. It is an annular ring of copper, corrugated as shown by the section profile line. This gives it greater elasticity and enables it to adjust itself to the surfaces to better advantage than if it were simply a flat plate. Another very simple form of metallic gasket is that shown in Fig. 9. It consists of two circles of round wire, the outer one being of copper and the inner one of lead. They are kept concentric by means of short wires soldered to each, the wires being extended several inches be-

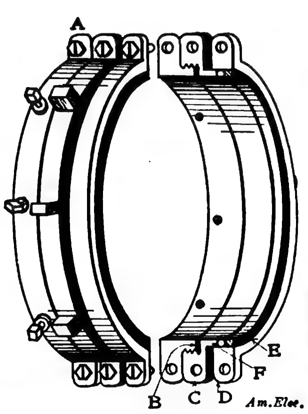

FIG. 10.

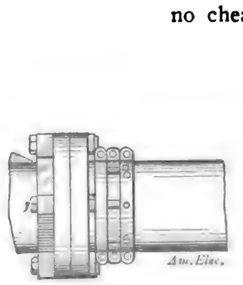

FIG. 10-A.

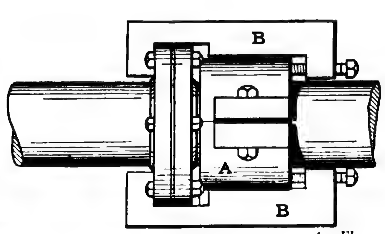

FIG. 11.

yond the outer ring. Besides holding the two circles together, these are used to center the gasket on the face of the flange by wrapping them around the bolts. The rings being of soft wire, they readily flatten under pressure, and thus spread over sufficient surface to produce a tight joint.

There is this disadvantage, however, in the use of a metallic packing. The coefficients of expansion of the soft metal and of the pipe are not the same, so that while the joint may be perfectly tight under full pressure, it leaks when the pressure is reduced, due to unequal expansion. This objection is not sustained, though, if the joint is kept under constant steam pressure.

The asbestos gasket is open to the objection that it softens by the absorption of water, and causes trouble by blowing out. All in all, the rubber gasket, with or without insertion, seems to be the standard. If properly "followed up" it will give excellent service. By "following up" is meant the tightening of the flange bolts after the gasket has been in service a short time. That is, if a joint is made in the morning, the nuts are screwed up tight enough to prevent leakage. During the day, the gasket becomes thinner, due to the high compressive stress, and attains more of a permanent set. In the evening, then, the nuts should again be tightened a little, to take up this alteration in thickness, and the process repeated, if necessary, the next day. A point will soon be reached at which there will be no further change, and under these conditions the joint may be left to itself with the expectation of reasonably long service.

Paper has been used to form gaskets, where the faces of the flanges were planed or turned, and so came together true and parallel. A piece of paper flour sack or tough wrapping paper, cut to the required form and given a coating of cylinder oil, has been found to make a durable and effective joint, and certainly there could be no cheaper. This form of gasket may be used on the planed joints of small steam pumps and steam engines. The purpose of the cylinder oil is to prevent destruction of the paper when subjected to high steam pressure.

In all flange joints except those with planed or turned faces, the surfaces of the flanges should be scored by a number of shallow concentric grooves. The gasket is compressed into these indentations, making it less liable to blow out.

The liability to leakage of screwed pipe joints has already been mentioned. These leaks are apt to develop at any time, and it is often absolutely impracticable to shut off the pressure to repair the defect. To enable immediate repairs to be made in such cases, there has arisen a class of devices known as pipe joint clamps. One form is illustrated in Fig. 10, showing the appearance both off the pipe and on it. There are three rings, made in halves and held together by screws. The first, *A*, is firmly clamped to the pipe by means of the set screws spaced at equal distances around it. It has a threaded lip *B*, which engages with the threaded portion of the collar *C*. Both *A* and *C* are of such internal diameter as to fit snugly to the pipe. The collar *D* is considerably larger inside, and contains a ring of packing *E* between itself and the pipe flange. The collar *A* being held tightly by the set screws, and the ring *C* being turned by means of a spanner, the lug *F* forces the packing toward the flange. Since the collar *D* prevents the packing from expanding, it is forced firmly against the pipe fitting and effectually stops the leak.

Where a flange joint is employed and a leak occurs between the pipe and the flange, the arrangement shown in Fig. 11 may be used to advantage. A collar *A*, made in halves, is put in place on the pipe, close to the flange. A piece of sheet rubber is held between it and the pipe, the rubber pro-

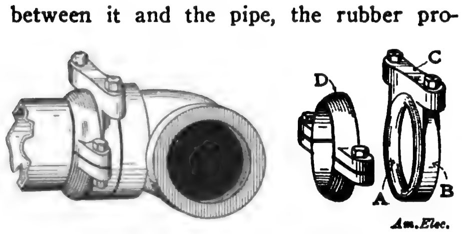

FIG. 12.

jecting a quarter of an inch or more toward the flange, and being flared so as to fully cover the joint. Then three clamps *B* are put in position and the set screws are tightened, forcing the packing hard against the flange, and thus preventing further escape of steam.

An extremely simple form of pipe clamp is illustrated in Fig. 12. The packing ring *A* is placed around the pipe, against the elbow or tee in which the leak has occurred. Then the flexible U-shaped band *B* is placed over it. The ends of this strap are threaded, and are passed upward through the yoke *C*, which is pressed down on the packing ring. Then the nuts are put on, and screwed up just enough to hold the packing in place. The split collar *D* is next firmly clamped around the pipe, against the packing. Finally, the nuts on the strap ends are tightened, and the packing, compressed between the yoke, the strap and the pipe, and unable to expand on the side next the collar *D*, is forced into the angle between the pipe and the edge of the fitting, making a perfect seal.

A WHOLE TOWN HEATED BY ELECTRICITY.

BY GEORGE E. WALSH.

The town of Davos, in the Swiss Alps, is famous for its dry, healthful climate, and in the winter season thousands of tourists and health-seekers sojourn there. It is situated at a high altitude, so that its winters are cold, but dry and invigorating, and its air so pure that two great sanitariums are occupied by people in search of health or recreation, or both. The question of heating the town of Davos and its two important sanitariums has vexed the local authorities for many years. The fear of contaminating the pure, dry air of the mountain resort with smoke and ashes finally led them to adopt electricity for all purposes—heating, cooking, lighting and power. There is a fixed population of some 3000 to-day, and a visiting population in winter of nearly as many more.

The question of the best form of heat for the sanitarium patients was also considered from a medical point of view. The physicians condemned gas and coal stoves on account of the unhealthy odors emitted by them, and steam heat for the houses and hotels was considered unhealthful also. Electricity was finally adopted as the best for all concerned, provided that it could be obtained at a reasonable cost.

The electricity for heating the town is supplied from power houses on the two streams, Landwasser and Albula, situated nearly ten miles away, where there is a fall of nearly 1300 feet. There is sufficient water power on these two streams to heat and light the whole town, and the final completion of the plant has enabled every inhabitant to use electricity for every household necessity.

The question of the amount of heat required to do all the cooking, heating and lighting of the town was one that could not be easily answered in advance, for there was no existing example for comparison. The town covers a district about two miles long and half a mile wide. In this space the large hotels and sanitariums are grouped.

A central station containing five units of 3000 horse-power each was orginally built with the expectation of furnishing all the electricity needed; but provisions were soon made for extensions. Each turbine is direct-coupled to two three-phase alternators, giving 8000 volts each, the two being coupled in a series to furnish 16,000 volts to the lines.

The heating of the houses was the most perplexing problem. The heating radiators consist of resistance coils covered by suitable enamel, and so placed in the rooms that the distribution of the heat is thorough. The cooking stoves consist of small alternating-current transformers that induce local currents in their bases. The heating was based upon the estimate that about 253 watt-hours per day would be needed for about 12 cubic feet of apartments. This amount of energy proved too high on warm winter days, and rather too low on very cold days; but the average throughout the year was not much astray.

The question of cost was vital. The annual expenses of the whole plant were found to be, the first year, about 830,000 francs, and the total consumption of energy 25,000,000 kilowatt-hours. At this ratio the cost of each kilowatt-hour averaged 3.3 centimes. This cost for heating is not excessive, although a little high for cooking purposes. However, the average for heating, cooking and lighting was considered reasonable, and the advantages obtained more than offset any slight increase in cost of the various classes of service. Those who have visited Davos since the installation state that the heating of the rooms is superior to anything before attempted, and the perfect temperature regulation obtained makes it immeasurably superior to coal or steam heat. The local physicians claim that the electrical heating of the houses and sanitariums is proving almost as beneficial for their patients as the dry, cool climate.

SYNCHRONOUS MOTORS IN CENTRAL STATIONS.

BY H. S. KNOWLTON.

The appearance of special machinery in central station practice is always a matter of interest, because it bears evidence of the existence of conditions somewhat out of the ordinary. As a rule the generation of alternating current and its transmission from a central station to moderate-voltage transformers in the business and residential districts of a city calls for nothing but standard apparatus. In the case of a plant which has been operated for a decade or two, however, it is frequently an advantage to employ special equipment to bring the station up to modern standards of flexibility.

An instance of this practice may be found in the Faraday Street station of the Worcester (Mass.) Electric Light Company. The Worcester plant was one of the first electric light stations in New England to be built on a large scale with the probable requirements of later years in mind, and its dynamo equipment, in accordance with the best practice of that day, was all belt-driven from extensive line shafts in the basement below the dynamo room. The arc lighting of the city was done by T-H machines; incandescent circuits were supplied by 133-cycle, 1040-volt alternators, and the few motors in use in printing offices, etc., were served with 500-volt direct current. To-day the line shafting is still in use for driving Brush arc-lighting machines and a 250-kw., three-phase alternator, and the power load is still handled by direct current; but the voltage has been doubled on the incandescent circuits, the frequency reduced to 60 cycles, and 2000 kilowatts in direct-connected alternators installed, with motor-driven oil switches and all the refinements of the latest switchboard practice. As an example of a plant that has been operated with economy and profit while undergoing a partial evolution in equipment, the Worcester station is of particular interest.

The synchronous motor of the plant is a 500-kw. General Electric machine of the revolving-field type. It is mounted upon the line shafting and may be used either as a generator or as a motor. It has a full-load efficiency of 94 per cent and at half load this falls to but 90½ per cent; the voltage of the machine is 2300. The arrangement is exceedingly flexible. In case either the 1200-kw. or the 800-kw. direct-driven alternators of the plant break down, or if their engines go wrong, the motor can soon be operated from the line shafting as a generator to help out the 250-kw. belt-driven alternator. If one or more of the three engines ordinarily used to operate the line shafting breaks down the motor is immediately available for operating the arc and 500-volt power generators. The motor thus constitutes a link between the belt-driven, direct-current machinery of the plant and the engine-driven alternators, and is a safeguard of no small importance in making it possible for the load to be held well up toward normal under adverse conditions. It will be interesting to watch the development of the Worcester station as the evolution of electric lighting proceeds.

An important use of synchronous motors on a large scale occurs in the practice of stations in which it is desirable to drive Brush arc machines by motors instead of by shafting, the main supply of energy coming from engine-driven alternators. Perhaps the most notable illustration of this practice occurs in the L Street station of the Boston Edison Company. Here are installed nearly two dozen arc lighting sets, each consisting of a 150-kw. synchronous motor direct-coupled to two Brush arc dynamos of 8500 volts and 6.6 amperes capacity. The speed of these sets is 514 r.p.m. and the synchronous motors take their current direct from the main 2250-volt bus-bars. The control of the power factor possible with this arrangement is an advantage, and it is unnecessary to use more than one type of alternating-current generator in the lighting and power service of the older section of the plant.

Another instance of synchronous motor practice has recently been mentioned in the technical press. It occurs in an electric light and power plant at Monterey, Cal., where a 162-kw. revolving-field motor is direct-coupled to a 150-kw. direct-current railway generator. At times of light load both machines may be driven as generators by a 200-h.p. engine, which is belted to a clutch pulley mounted on the motor-generator shaft. This arrangement enables both units of the motor-generator set to be run as generators when the load is light, and the railway load may be coupled in with the alternating load at will, giving most efficient operation during the daytime.

It must not be concluded, however, that special equipment of this sort is applicable indiscriminately under all conditions of plant operation. As far as possible it is wise to cut down to a minimum the extra transformations of energy in plants, and it is only when increased flexibility is worth more than the additional losses incurred that it is desirable to insert special equipment in the chain of apparatus between the coal pile and the distributing mains.

AMERICAN WATER-WHEELS AND WATER-WHEEL GOVERNORS

BY LAURENCE B. MATHER.

There are two general types of water wheel in use in America for driving electric generators, the turbine, based on the inverse of the screw propeller principle, and and the impulse or impact type, operated by the direct pressure of a water jet delivered from a nozzle. The turbine is applicable under low and moderately high heads; the impulse wheel is particularly well adapted for operation under very high heads, and has therefore come into wide use in the West where such heads abound.

Turbines are mounted in a variety of ways, the manner of mounting depending largely on local conditions. The simple vertical turbine mounted on the floor of a wooden penstock, as in Fig. 1, is probably the most familiar disposition, and is the easiest and cheapest in installation. It involves the serious disadvantage, however, of using either a special generator of the vertical type and designed for very low speeds, or ponderous gear wheels between the upper end of the turbine shaft and a horizontal shaft from which generators of conventional types may be belt driven. A steel casing and flume are used to a great extent with vertical wheels, however, this arrangement obviating the many disadvantages of wooden structures in wet places; such an arrangement is shown in Figs. 2 and 3. The steel casing is provided with hand-holes and man-holes through which access to the wheel and gate mechanism may be had when necessary.

By far the best method of mounting turbines for electric station purposes, however, is to place two wheels on a single horizontal shaft within a steel casing, the water being delivered to the casing in the center and discharging at both ends through huge elbows to draft tubes, as in Fig. 4. This method equalizes the end thrust, making step bearings unnecessary. It also has the advantage of making the turbine shaft accessible for generator driving without the

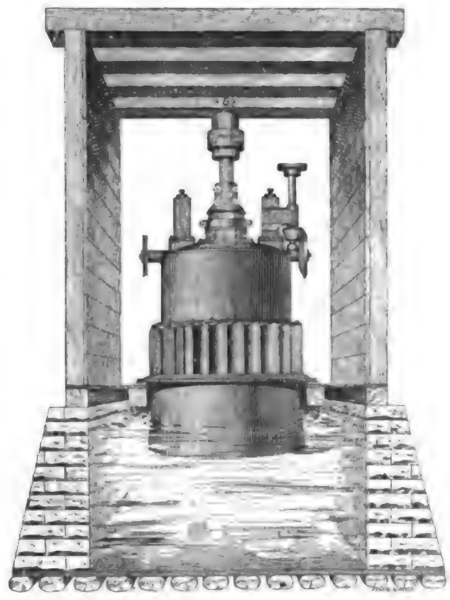

FIG. 1.

intermediary of gears or the use of specially designed generators. Twin horizontal turbines are sometimes mounted in the reverse manner, *i. e.*, with the discharge in the center and the intakes at the ends; this arrangement is not so good as the other, for the reason that the turbine discharge streams meet and each imposes a slight back pressure on the other; the central space cannot be made large enough to prevent this because it must be completely filled with water during the turbine operation in order to enable the wheels to work at maximum efficiency with relation to the supply head.

The delivery of water to a turbine is controlled invariably by means of "gates" in the turbine casing (not the steel casing which takes the place of a wooden penstock, but the immediate casing of the wheel itself). Three general types of gate are in use: the inside cylinder, outside register and the wicket gate. These are described in connection with the turbines in this article, so that a separate description here is not necessary.

One of the oldest American builders of turbines is the Dayton Globe Iron Works Company, Dayton, Ohio, which concern is the development of the business begun in 1853 by Stout, Mills & Temple. The "runner" of the American turbine built by this company is illustrated by Fig. 5. The water enters the wheel in the upper part and imparts motion to it by reason of the fact that the buckets or, more accurately, blades, are curved and the water presses against them like a solid wedge against a sloping surface. Passing through the blades or upper parts of the buckets the water is discharged from the lower parts of the buckets, which are also curved so that the passage of water through them increases the rotative effect of the water upon the wheel. The American wheel is built with either wicket or cylinder gates, as desired. The wicket gate of this wheel is a most ingenious one. Fig. 6 shows the cross-section of the wheel and case and Fig. 7 the top of the wheel-case crown-plate to which the gates are attached. The gates are pivoted to the crown plate and the pivot is shielded by a pocket in the end of a stationary guard or fender, which fender also protects the gate from the inward pressure of the water, making it easy to move. The gates are swung to and fro

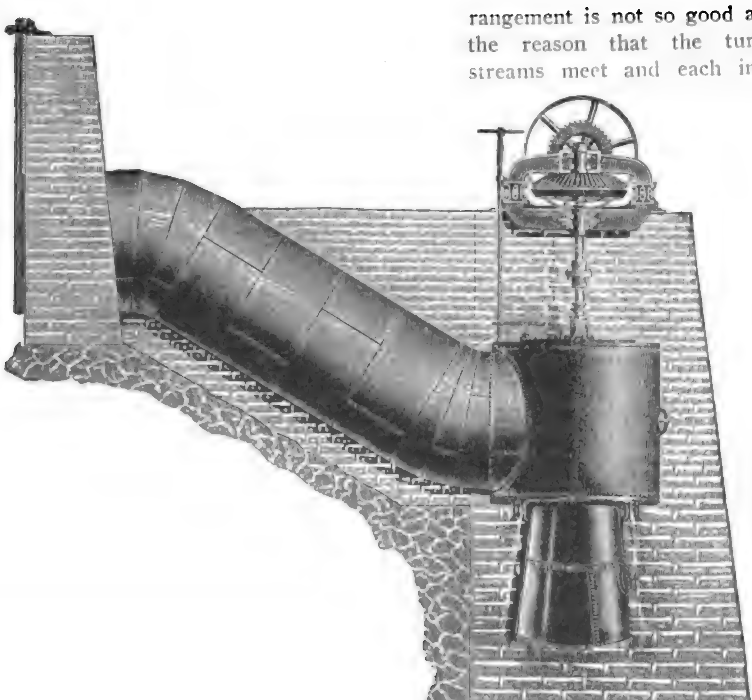

FIG. 2.

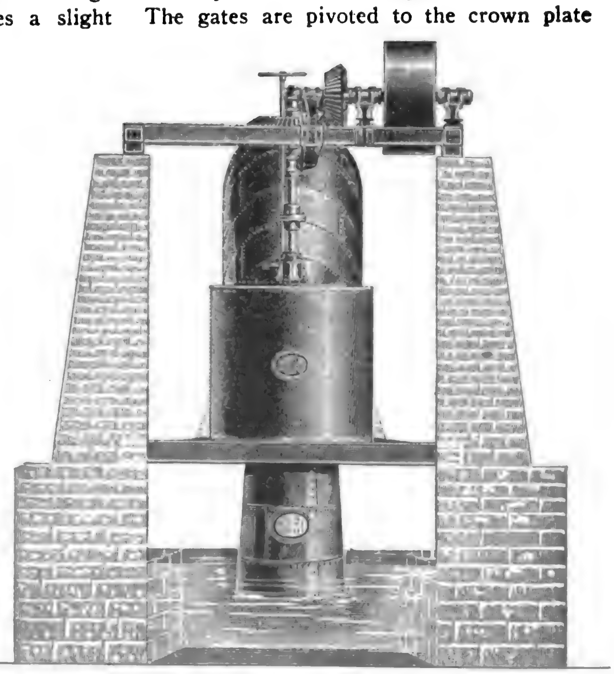

FIG. 3.

by means of links pivotally attached to them near the "knuckles" and attached at their other ends to a ring mounted on the crown plate concentric to the wheel shaft;

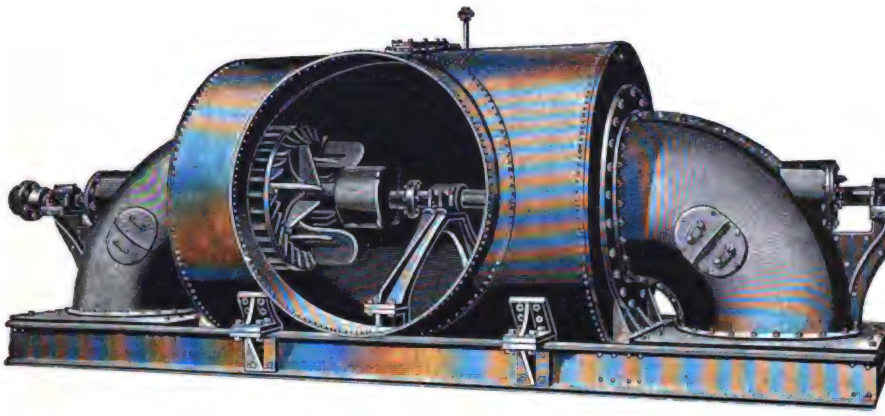

FIG. 4.—TWIN HORIZONTAL TURBINES; CENTRAL INTAKE.

to this ring is bolted a segmental gear and this meshes with a pinion on the end of the

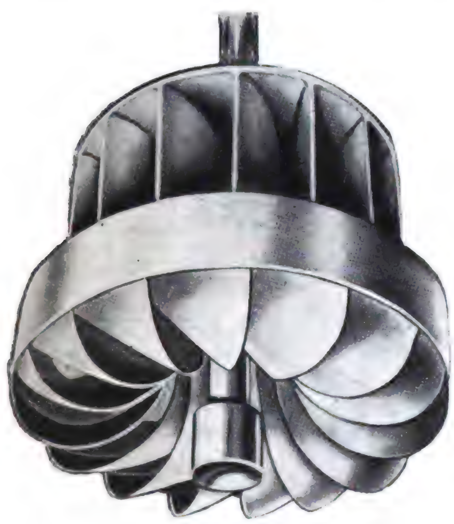

FIG. 5.—RUNNER OF AMERICAN TURBINE.

gate-controlling shaft. The New American cylinder gate is similar to that used on other turbines, one of which is described farther along. The turbine is built in sizes

FIG. 7.—AMERICAN GATE GEAR.

ranging from 13 to 60 inches. The 34-inch wheel, under a 25-foot head, runs at 249 r.p.m. and develops 309 horse-power with a water consumption of 8050 cubic feet per minute. The company also builds a "reduced discharge" wheel for high heads—40 to 100 feet—in sizes ranging from 16½ to 59½ inches; the 36-inch wheel develops 245 horse-power under a 40-foot head, making 226 r.p.m. and taking 4057 cubic feet of water per minute.

Fig. 8 illustrates the turbine built by the Chase Turbine Manufacturing Company, Orange, Mass., and Fig. 9 shows the runner

FIG. 6.—AMERICAN GATE GEAR.

of this turbine. As the engraving plainly shows, the wheel is of the single-bucket type, the water passing through it wholly in a downward direction. This wheel has

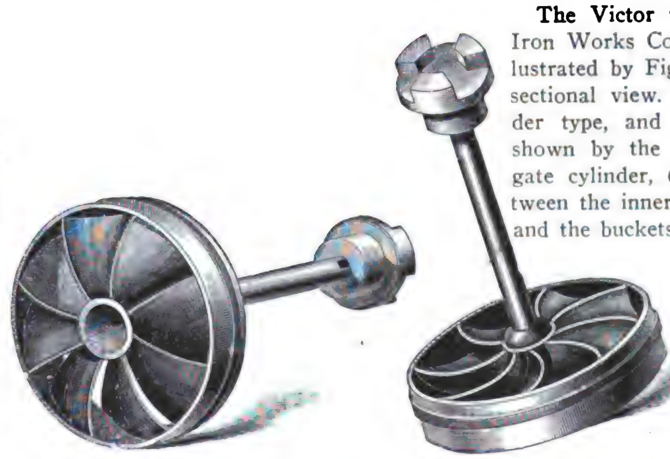

FIG. 9.—RUNNER OF CHASE TURBINE.

the advantage of light weight, high speed and straight flow. The water is admitted at the side of the case through a butterfly gate, as shown by Fig. 8; the case is sufficiently high to allow the water to change its direction of flow from horizontal to downward without undue friction against the walls and without causing eddies. The gate, being pivoted in the center of its vane,

FIG. 8.—CHASE TURBINE.

is balanced and therefore opens and closes easily. The Chase "Special" 48-inch wheel under a 25-foot head develops 292 horse-power at 220 r.p.m. with a water consumption of 8354 cubic feet per minute.

The I-X-L vertical turbine and the X-L-C-R twin horizontal style built by the Humphrey Machine Company, Keene, N. H., are shown by Figs. 10-A and 11. These are of the double bucket type, and have shown rugged characteristics under hard and long service. These wheels are relatively slow-speed; the 68-inch single vertical wheel under a 25-foot head runs at only 88 r.p.m. and develops 265 horse-power with a water consumption of 5614 cubic feet per minute; the twin horizontal wheels run at the same speeds as the verticals of the same diameter and develop twice the power, of course.

The Victor turbine, built by The Platt Iron Works Company, Dayton, Ohio, is illustrated by Fig. 12, of which Fig. 13 is a sectional view. The gate is of the cylinder type, and its arrangement is clearly shown by the sectional illustration. The gate cylinder, *G*, slides up and down between the inner circle of the chute case, *C*, and the buckets of the wheel, *W*. A hori-

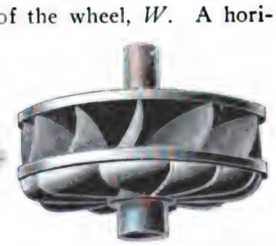

FIG. 10.—HUMPHREY RUNNER.

zontal gate shaft carries two pinions which mesh with two racks attached to vertical slides which are in turn attached at their lower ends to the gate cylinder. The shaft projects through the

wheel case at one end and that end carries a bevel wheel, outside the case, which meshes with a mate wheel on the lower end of the hand-wheel shaft, as shown in Fig. 12. The chute case is a single casting, to which

FIG. 10-A.—HUMPHREY TURBINE.

are bolted the upper and lower parts of the wheel case; the lower part of the wheel case, as will be noted from the engravings, is flared considerably, increasing the area of the discharge and thereby decreasing the velocity of the water in the draft tube as compared with that through the wheel itself. The runner of the regular Victor turbine is shown in Fig. 14, which shows it to be of the double-curve-bucket type. It is cast in a single piece, and the band around the lower ends of the upper bucket blades is turned up true so as to get accurate mechanical balance as well as to reduce the clearance between it and the case to the smallest practical dimension. Fig. 15 shows the Victor high-pressure runner, which differs from the regular runner chiefly in the increase in the central space surrounded by

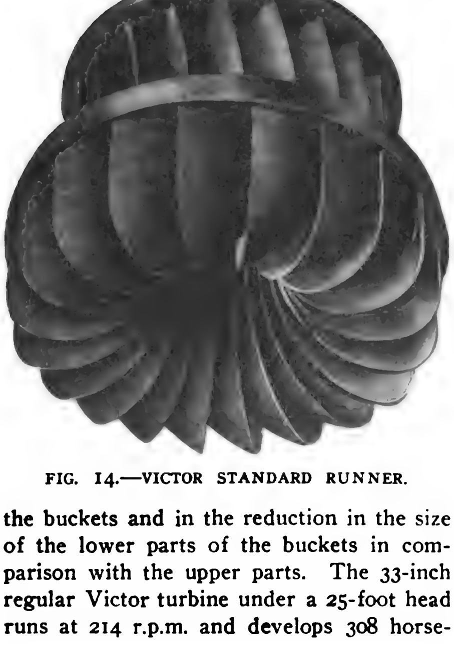

FIG. 14.—VICTOR STANDARD RUNNER.

the buckets and in the reduction in the size of the lower parts of the buckets in comparison with the upper parts. The 33-inch regular Victor turbine under a 25-foot head runs at 214 r.p.m. and develops 308 horse-power with a consumption of 8142 cubic feet of water per minute.

The runner of the McCormick turbine, built by the S. Morgan Smith Company, York, Pa., is shown by Fig. 16. This is

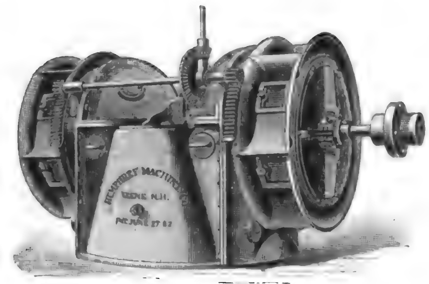

FIG. 11.—TWIN HORIZONTAL HUMPHREY TURBINE.

obviously of the double-curve-bucket type, the water entering the upper parts of the buckets and passing out from the lower parts. The entire wheel is cast solid in one piece, and the band around the change in curvature of the upper and lower parts of the buckets binds fully one-half the length of each of the bottom buckets. The cylinder

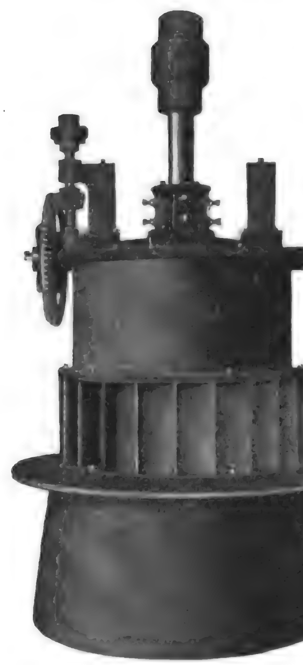

FIG. 12.—VICTOR TURBINE.

type of gate is used, the chute case being cast in one piece and the upper and lower cylindrical parts of the case being bolted to it, as shown in Fig. 17. The gate is a cylinder of iron arranged to slide up and down between the inner ends of the chute blades and the outer rim of the runner, as in the case previously described. The gate has two lifting bars which pass upward through the top of the chute case and terminate in racks, as shown in Fig. 17, the racks meshing with two spur gears on a horizontal shaft and this shaft being controlled by the usual vertical gate shaft through bevel gears. On the horizontal shaft is a grooved wheel about which is wound a chain which passes up over an idler secured to the penstock structure overhead; the end of the chain is attached to a weight which serves to counterbalance the gate, the chain being wound around the grooved wheel on the horizontal gate shaft in the proper direction to accomplish that result, of course. The 36-inch McCormick turbine, under a 25-foot head, runs at 177 r.p.m. and develops 280 horse-power utilizing 7414 cubic feet of water per minute.

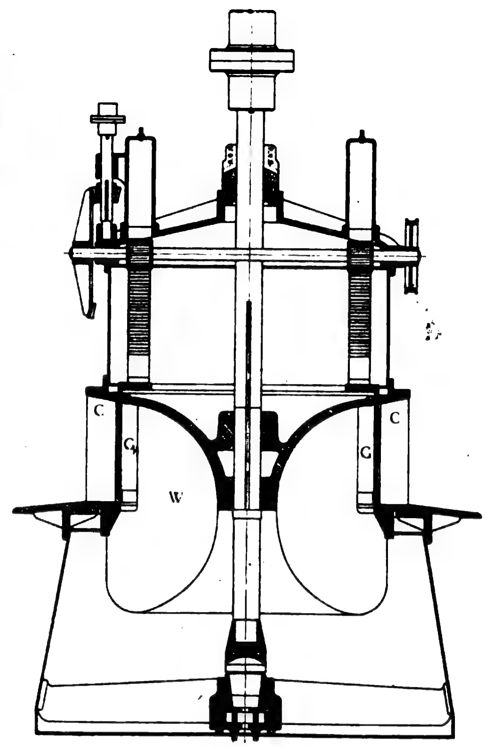

FIG. 13.—SECTIONAL VIEW OF VICTOR TURBINE.

The Alcott turbine, built by the Risdon-Alcott Turbine Company, Mount Holly, N. J., is provided with either register gates or cylinder gates, as desired by the purchaser. The former type is shown in Fig. 18 and the latter in Fig. 19. The outside register gate consists of a system of chute covers attached to a ring, the latter being bolted to arms radiating from a collar on the stuffing box of the wheel case; rotating this structure moves the gates over or away from the chute entrances in much the same fashion that the wings of an ordinary stove damper cover or uncover the openings in the side

FIG. 15.—VICTOR HIGH-PRESSURE RUNNER.

of the stove. The Risdon cylinder gate is similar to those already described, but it embodies detail differences which render it unnecessary to make the wheel case much higher than is actually required to

clear the runner. The gate itself slides up and down through an annular opening in the case, and it is mounted on a spider which slides up and down on the stuffing box of the wheel case. The hub of the

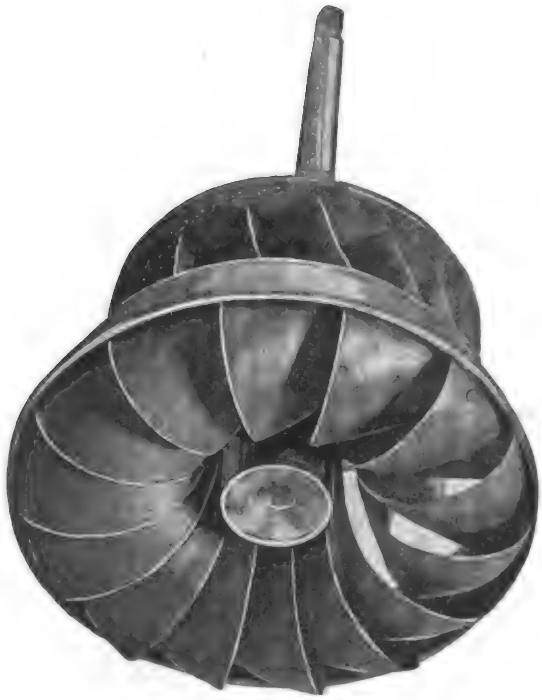

FIG. 16.—RUNNER OF M'CORMICK TURBINE.

spider is provided with a rack to mesh with a pinion on the horizontal shaft, this latter shaft being bevel geared to the vertical gate shaft, as in some of the cases previously considered. The crown plate of the wheel case and the chute case are connected by means of U-shaped arms which straddle the gate cylinder, as shown in Fig. 19. The

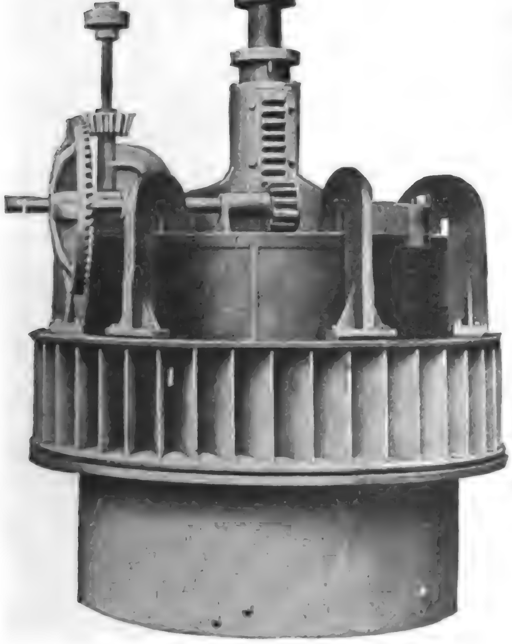

FIG. 19.—RISDON CYLINDER GATE TURBINE.

Alcott "special" runner is shown in Fig. 20; it is of the double bucket type, but it will be noticed that the lower parts of the buckets are somewhat flatter than in previous cases. The outer edges of the upper parts of the buckets, where the water enters the runner, also differ from other designs in that they curve more sharply in the direction of rotation, the object of this construction being to allow the water to enter

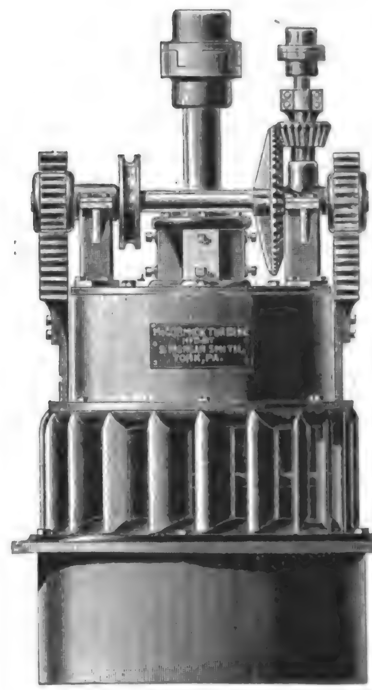

FIG. 17.—M'CORMICK TURBINE.

the buckets easily and without abrupt pressure upon the wheel. The 42-inch Risdon-Alcott "Special" turbine, under a 25-foot head, develops 310 horse-power at 150 r.p.m. and passes 8284 cubic feet of water per minute.

The Samson turbine, built by The James Leffel & Company, Springfield, Ohio, has the distinctive feature of two separate sets of buckets, one of the double-curve type already described, and the other of a type intermediate between the upper and lower parts of the double-curve bucket. The runner of this turbine is illustrated by Fig. 21, in which the two sets of buckets are clearly shown. The upper buckets are cast between

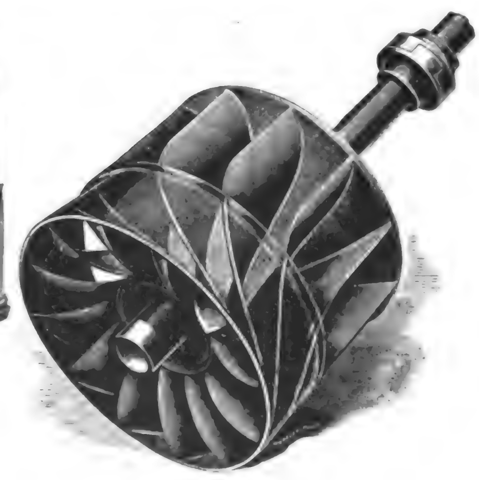

FIG. 20.—ALCOTT SPECIAL RUNNER.

the upper bell of the wheel and the diaphragm which separates these from the lower buckets; the lower buckets, of the double-curve type, are of flanged plate steel cast into the diaphragm and the outer band. The water enters the wheel case through balanced wicket gates and passes through the two sets of buckets "in parallel" so to speak; that is, part of the water goes through the upper set of buckets and part through the lower, double-curve buck-

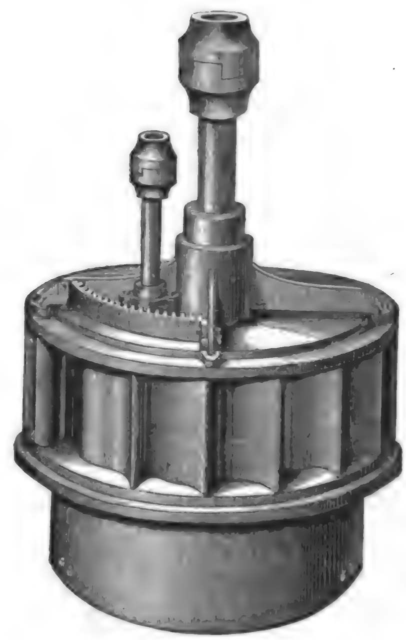

FIG. 18.—ALCOTT TURBINE WITH REGISTER GATES.

ets, the former discharging from the center of the wheel and the latter from the circle of buckets nearer the rim. The 35-inch Samson turbine, under a 25-foot head, passes 8050 cubic feet of water per minute and develops 308 horse-power at 232 r.p.m.

The "Little Giant" turbine, built by William Dowling & Company, Logansport, Ind., is illustrated by Figs. 22 and 22-A. This is of the same general type as the double-curve-bucket turbines already described, but there are differences in the constructional details, such as the curvature of the buck-

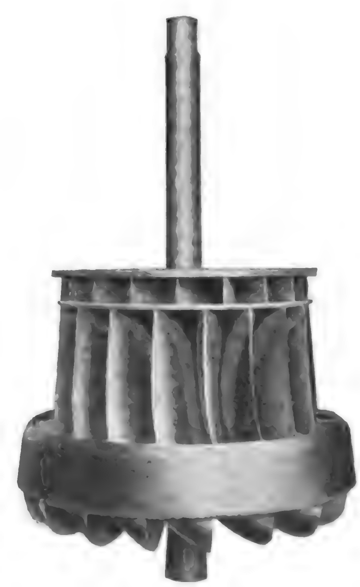

FIG. 21.—SAMSON RUNNER.

ets, which cannot well be described in an article of this general character. Cylinder gates are used, with a horizontal gear shaft projecting through the wheel case at both sides; one end of the shaft is bevel-geared

to the vertical gate-control shaft and the other carries a grooved wheel to take a chain running up over an idler and down to a counterbalancing weight, as in another case described. As Fig. 22-A clearly shows, the gate racks do not pass through the top of the wheel case, but are housed in square "chimneys" bolted to the case. This illus-

FIG. 22.—LITTLE GIANT RUNNER.

tration gives an excellent idea of the relations of cylinder gate turbines with double-curve buckets and the gate cylinder and wheel case. The "Little Giant" runner is constructed somewhat differently from

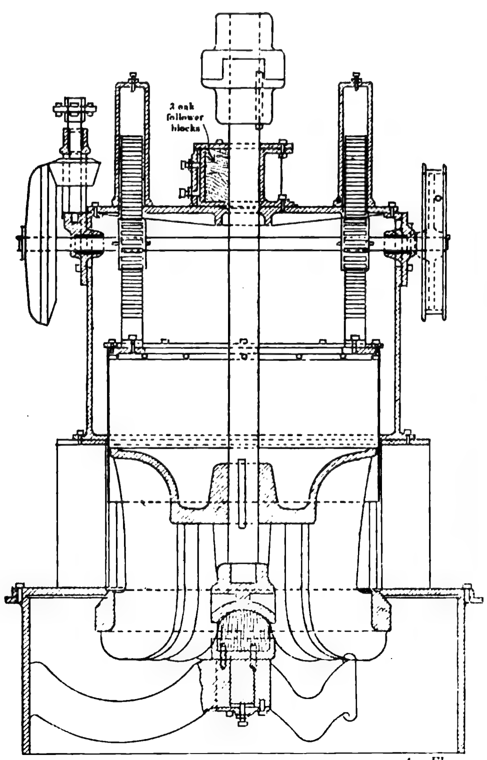

FIG. 22-A.—SECTIONAL VIEW OF LITTLE GIANT TURBINE.

the usual double-curve turbine. The buckets are cast separately, each with a dovetail edge where it joins the bell or cone-shaped central part of the runner and at the outer edge where it joins the band near the bottom of the runner. The buckets are set up in a flask and the outer band and central cone are cast about them, the molten metal embracing the dovetail edges of the buckets as it fills the mold. Another feature of the wheel is the step cone; this is hollowed out, as usual, to fit a convex lignum vitæ step, as shown in Fig. 22-A, but it has openings cored in the sides so as to allow the water to enter the bearing near the top and keep the step lubricated. This simple expedient, the builders state, has absolutely prevented heating and burning of the step. The "Little Giant" is the outcome of the original Obenchain turbine patented 34 years ago by Matthew and John Obenchain, who were then members of the firm which is now William Dowling & Company. The 34-inch turbine under a

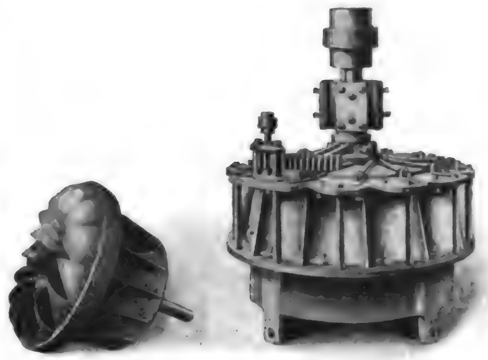

FIG. 23.—TRUMP VERTICAL TURBINE.

25-foot head runs at 200 r.p.m. and develops 285 horse-power with a water consumption of 7434 cubic feet per minute.

The Trump Manufacturing Company, Springfield, Ohio, builds two classes of turbine, both having double-curve buckets; one is for medium and low head and the other especially designed for high heads. The

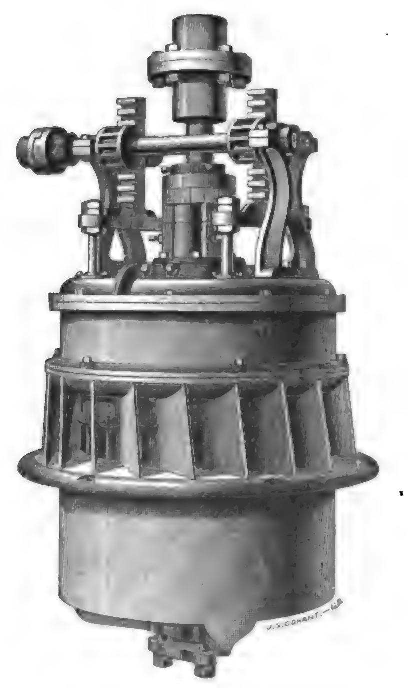

FIG. 25.—HUNT TURBINE; OUTSIDE GATE GEAR.

essential features of the two are the same, with the exception of the gate mechanism which is of the wicket type shown in Figs. 23 and 24 for low and medium heads; the gate mechanism of the high-head turbine is completely housed and devoid of links and joints. The runner of the Trump turbine slopes from the top of the bell to the outer band to the extent of 20 per cent; that is, the diameter is 20 per cent greater at the band than at the top of the bell where the buckets start. An important feature of this turbine is the absence of the usual step bearing. The lower end if the turbine shaft is centered in a tapered bearing as show at *E, E,* Fig. 24; the weight of the wheel is supported, however, by a water

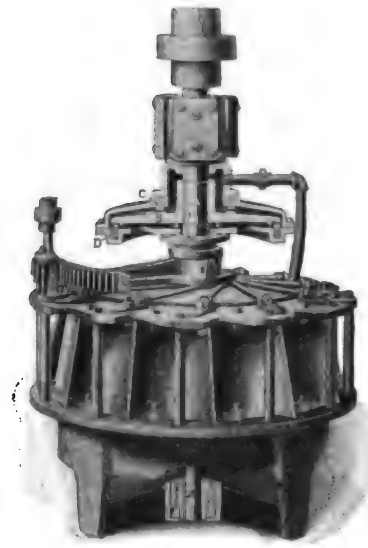

FIG. 24.—TRUMP VERTICAL TURBINE, SHOWING WATER CUSHION.

cushion immediately above the wheel case. This consists of a disc, *B*, secured to the turbine shaft and entirely enclosed by a circular casing, except for holes in the under part through which the water enters from the penstock. The disc rotates between two lignum vitæ rings, *C* and *D*, with such small clearance that the quantity

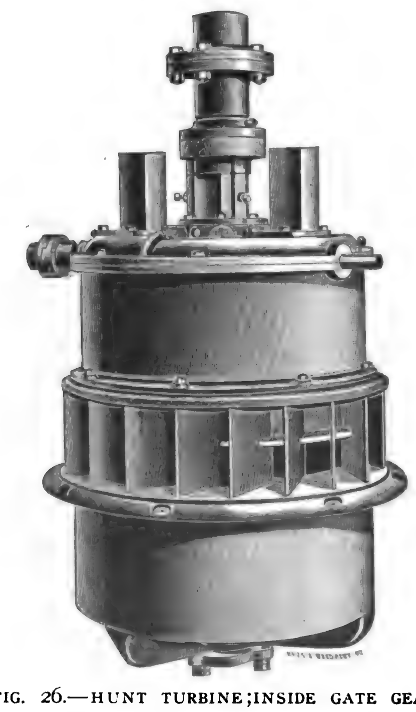

FIG. 26.—HUNT TURBINE; INSIDE GATE GEAR.

of water leaking past the disc is negligible. The upper part of the casing is connected to the wheel case by a small pipe, shown on the right, which takes out all leakage and by means of which the suction due to the passage of water through the turbine maintains a partial vacuum above the disc.

The upward pressure of the water entering through the holes in the bottom of the disc case lifts the turbine runner sufficiently to raise the disc off the ring *D* and float the runner, shaft and all. This water cushion is of great advantage also in turbines mounted horizontally; it eliminates the step

FIG. 27.—CROCKER TURBINE RUNNER.

bearing without making it necessary to mount two wheels on a single shaft.

The Rodney Hunt Machine Company, Orange, Mass., builds turbines with double-curve buckets also. The author has been unfortunately unable to obtain any information as to the constructional details of the runner; the gate rig is shown by Figs. 25 and 26. Cylinder gates are used, the only difference between the two arrangements illustrated being in the disposition of the gate racks and pinions. In Fig. 25 the racks and pinions are on top of the wheel case and the racks are attached to the gate by means of rods passing through stuffing boxes in the top of the case; in Fig. 26 the entire rigging is enclosed in the wheel case, the racks being housed by "chimneys" and the gate shaft projecting through the sides of the wheel case. The 42-inch Hunt tur-

FIG. 31.—PELTON RUNNER.

bine under a 25-foot head develops 302 horse-power at 150 r.p.m. and passes 7720 cubic feet of water per minute.

The Crocker turbine, built by the Turners Falls Machine Company, Turners Falls, Mass., has double-curve buckets also, and is equipped with either balanced cylinder gates or wicket gates. The buckets are cast separately and set into the body and outer band; inspection of Fig. 27 will show that the band flares outward at an angle of almost 45 degrees, giving a rapidly increasing discharge area. Another feature peculiar to this turbine is that the upper parts of the buckets are reverse-curved, the slope from top toward the bottom being in the direction of rotation. The 30-inch wheel runs at 244 r.p.m. under a 25-foot head, takes 6680 cubic feet of water per

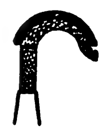

FIG. 28.

FIG. 29.

minute and develops 253 horse-power; the 36-inch wheel runs at 203 r.p.m., takes 10,350 cubic feet of water and develops 380 horse-power.

Tangential water wheels are built by several manufacturers, all of whom are located on the Pacific coast, this type of wheel being best adapted for the very high heads which are found in the Western part of this country. The tangential wheel consists essentially of a spider or disc mounted on a shaft and carrying around its rim a row of concave buckets; a stream of water is delivered to the buckets from a nozzle, and the force of the jet acting on the buckets drives the wheel around in somewhat the same manner as the weight of the water delivered to the paddles of an

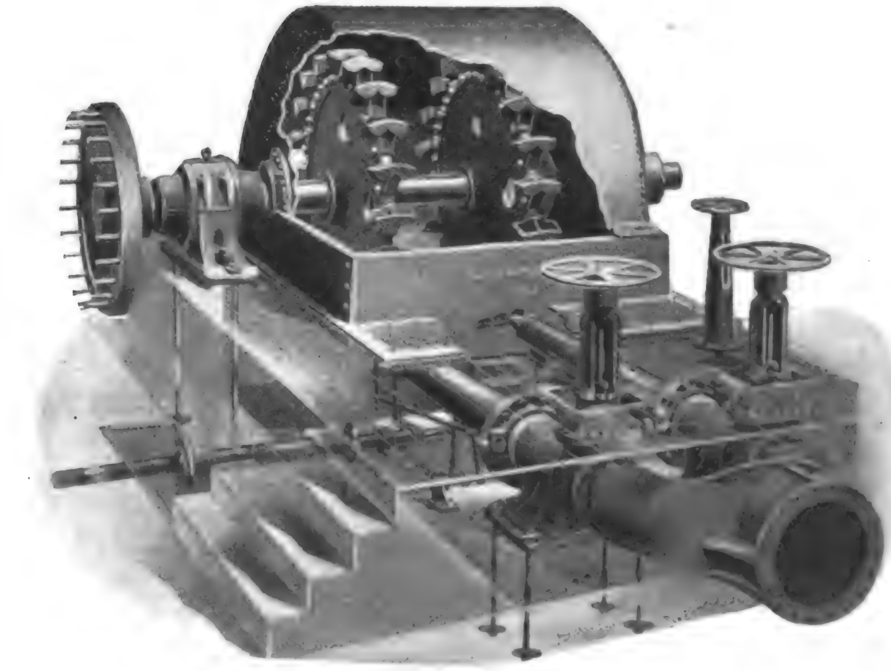

FIG. 32.—PELTON UNIT IN TELLURIDE POWER HOUSE.

overshot wheel turns the wheel. There is a wide difference, however, in the fundamental principles of the tangential wheel and the old-fashioned overshot wheel; the latter is driven solely by the weight of the water held in its buckets while the tangential wheel is driven by a combination of the direct force of the high-pressure jet delivered against its buckets and the reaction of the water upon the buckets after it has reached them. This reactive effect is obtained by curving the buckets so that the water jet is completely reversed in direction, as indicated in Fig. 28. Since the reaction of the jet on the bucket due to its change in direction is less than the initial effort due to the impact of the jet, a jet delivered as indicated in Fig. 28 would exert a sidewise effort on the bucket; this is obviated in most tangential wheels by the use of a split bucket, as indicated in Fig. 29, which divides the jet and equalizes the side thrust.

FIG. 30.

Three general types of bucket are used: the straight lip bucket with substantially rectangular outline, the ellipsoidal bucket with the lip cut away to clear the jet, and the cup-shaped bucket, intermediate between the first two. The straight lip bucket is used by the Pelton Water Wheel Company; Fig. 30 shows this type and Fig. 31 shows a complete Pelton runner. Fig. 32 is an illustration of the 2000-hp. Pelton double unit in the celebrated Telluride (Colorado) transmission plant, and shows very well the method of mounting tangential wheels and their nozzles. The methods used by the Pelton Company, of San Francisco, in determining the action of the water stream upon the wheel buckets were fully described in the June, 1904, number of this journal, and will be found of much interest to those concerned.

The Abner Doble Company, San Fran-

cisco, builds tangential wheels with ellipsoidal buckets, Fig. 33 showing a twin bucket and Fig. 34 a complete Doble runner. The nozzle used with the Doble wheel is highly interesting. It is of the needle-regulating type, but the shape of the needle and the inner wall of the nozzle have been very carefully worked out. These are clearly shown in Fig. 35. The stream delivered by this nozzle is perfectly clear, smooth and solid; entirely devoid of the spraying and foamy appearance of a stream from the ordinary nozzle. Speed regulation for changes in load is effected by means of a governor which deflects the nozzle and "spills" part of the jet when the speed increases; the needle is adjusted by hand to suit the average load; that is to say, it is adjusted to such a position that the governor will not need to deflect the nozzle under average conditions and the buckets will receive the full jet under such conditions. The front lip of the bucket is cut away as shown in Fig. 33 in order to prevent the lip from striking the jet flatwise as the bucket enters the jet and also to prevent splitting the jet horizontally as the lip passes the horizontal plane of the jet. It is stated that this form of lip and bucket avoids all disturbance of the jet and accomplishes the reversal of the jet with no loss of energy except that due to the unavoidable friction of the water against the bucket walls.

FIG. 33.—DOBLE TWIN BUCKET.

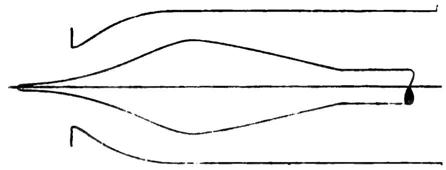

FIG. 35.—DOBLE NOZZLE.

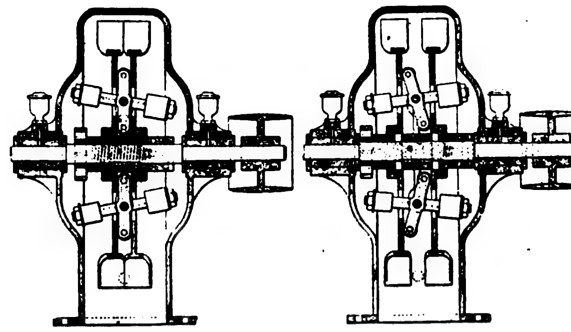

FIG. 37.—CROSS-SECTIONAL VIEWS OF CASSEL WHEEL.

The Cassel Automatic Water Motor Company, Seattle, Wash.; builds a tangential wheel which embodies a speed-regulating feature of absolute originality. The wheel is made in two parts, each carrying a complete set of half-buckets, as shown in Fig. 36. The two spiders are mounted on a common shaft and arranged to slide along the shaft, their relative positions being determined by means of governor weights. This principle is illustrated by Fig. 37, which shows the wheel with the buckets closed and open. In the former condition, it acts like an ordinary twin bucket wheel but in the latter, the separation of the bucket halves allows part of the stream to pass between them and thereby reduces the speed of the runner. The spiders are normally pressed together by the heavy coil springs shown in Fig. 36; their separation is due to the centrifugal effect of the heavier of two sets of weights mounted on horizontal arms which are linked to the spiders by means of cross-bars. Fig. 38 shows a modification in which the governor is of the familiar type seen on automatic high-speed steam engines; the weights and springs control the positions of the bucket spiders in the casing through the medium of links and a collar passing through the case near the center. The builders state that tests of this wheel under a 1000-foot head have shown a speed variation of only 1.7 per cent between no load and full load.

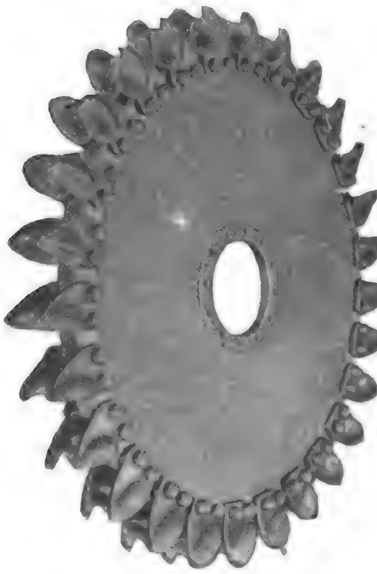

FIG. 34.—DOBLE RUNNER.

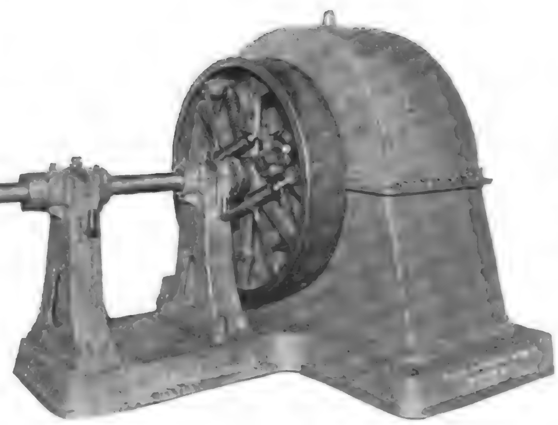

FIG. 38.—CASSEL TANGENTIAL WHEEL.

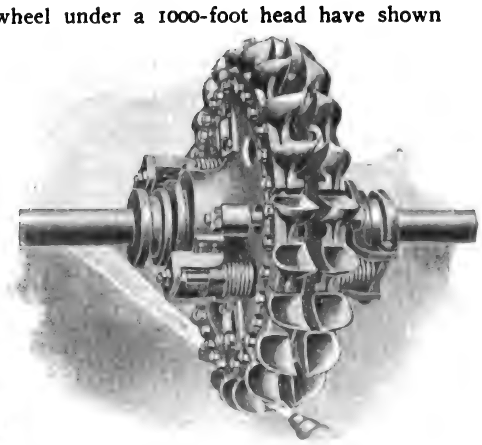

FIG. 36.—RUNNER OF THE CASSEL TANGENTIAL WHEEL.

The tangential wheel, built by the Joshua Hendy Machine Works, San Francisco, is illustrated by Fig. 39. The buckets are of the double-cup type referred to at the beginning of this section of the article. Fig. 40 illustrates the Chavanne needle-regulat-

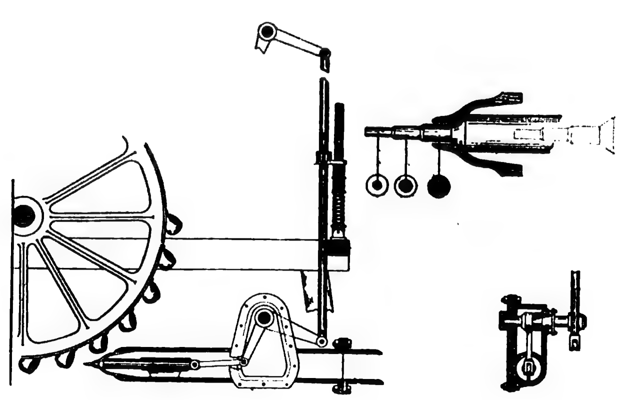

FIG. 40.—CHAVANNE NEEDLE REGULATING NOZZLE OF THE HENDY WHEEL

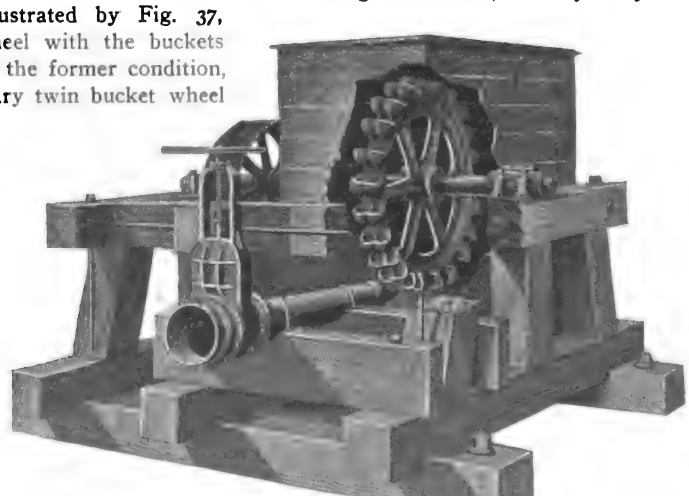

FIG. 39.—HENDRY TANGENTIAL WHEEL.

ing nozzle used with the Hendy wheel; the jet is regulated by the adjustment of the needle which is not made continuously tapering, as in some other nozzles, but has three distinct diameters, as shown in the upper right-hand part of the engraving.

FIG. 41.—TUTTHILL RUNNER.

The Tutthill tangential wheel, built by the United Iron Works, of San Francisco, differs from all of the wheels previously described in that the buckets are not of the split type and are staggered on the rim of the wheel, as shown in Fig. 41. Each bucket takes the entire stream from the nozzle, but the discharge from the buckets is alternately on the right and left of the central spider, as indicated by Fig. 42. One object in staggering the buckets instead of having all of them on one side of the wheel is the same as that in using the divided bucket of the Pelton and other wheels, namely, to avoid unbalanced side stress on the wheel, which would necessitate a step bearing or thrust at one end of the shaft. Another reason for this arrangement of buckets is that the discharge being alternately from opposite sides of the wheel, the water from one bucket does not strike the next succeeding bucket and cause waste of power.

FIG. 42.

Water-wheel Governors.

Figs. 43 and 44 illustrate the "Improved" governor built by the Holyoke Machine Company, Worcester, Mass. The pulley *A* is driven at about 400 r.p.m. by a belt from the water-wheel shaft; the governor mechanism in the pulley, which is similar to the shaft-type of governor for steam engines, controls the two levers, *K* and *L*, which actuate a piston slide valve within the barrel *N*. This valve admits water under pressure to either one end or the other of the working cylinder *O* which contains a piston; the piston rod is attached at its outer end to the upper end of the lever *G*, Fig. 43, which carries in the circular part at its center a pivoted nut *V*. This nut is threaded on the end of a rod *F* which, when moved endwise, sets one of two friction clutch discs, *D, D*, which are driven in opposite directions by gears from the shaft of the governor wheel *A*. One of the clutches, therefore, drives the gate shaft (*J*, Fig. 44) in one direction and the other drives it in the opposite direction, through the gears *R* and *S*. The spindle *F*, Fig. 43, carries a sprocket wheel over which the chain *H* runs, and this chain also runs over a sprocket on a small spindle driven by whichever clutch disc is made active by the governor wheel. When the governor admits water to the working cylinder, the piston sets one of the disc clutches by moving the lever *G*; the spindle driving the chain *H* is then driven by the clutch in such a direction that the rotation of the spindle *F* by the chain and sprocket moves the lever *G* in the opposite direction from that in which it was first moved by the water piston. This arrangement prevents overrunning and "hunting."

The governors made by the Lombard Governor Company, of Boston, Mass., consist primarily of a hydraulic piston which applies its thrust in either direction to the water-wheel gates in the act of opening or closing them. The piston rod terminates in a rack geared to the gate shaft, and since one complete stroke of the governor piston opens or closes the water-wheel gates, any motion of the governor piston less than a complete stroke causes a correspondingly smaller motion of the gates. For example, if the governor piston moves one-half its complete travel it will half open or close the water-wheel gates, and if it moves one-tenth its full stroke it opens or closes the gates one-tenth. This action may be seen in a general way from Fig. 45, which illustrates the "Type F" governor. This governor, which is the simplest and smallest made by them, is adapted to regulating Pelton and all other forms of impulse or tangential water-wheels. Its piston terminates in a rack which rotates a gear sector, and the central shaft of this sector is coupled or geared to the rock shaft controlling the deflecting nozzle. When used to regulate a small turbine, the central shaft of the gear sector is coupled to the gate stem. Thus it will be seen that as the piston travels in or out the nozzle will deflect the water from or to the water-wheel, or open or close the gates of the turbine, as the case may be. In the governor shown in Fig. 45 the hydraulic piston is moved by water under flume pressure. There is a pipe-threaded orifice under the bed of this governor which is connected directly to the flume. Therefore this type of governor is chiefly adapted to high head plants, or to low head plants where a small amount of water is available under high pressure. Where the water-

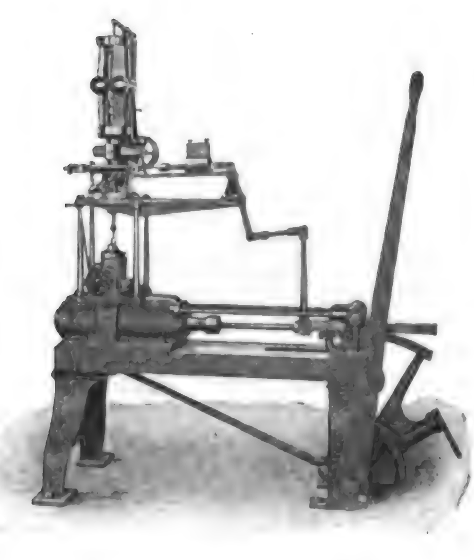

FIG. 45.—"TYPE F" LOMBARD GOVERNOR.

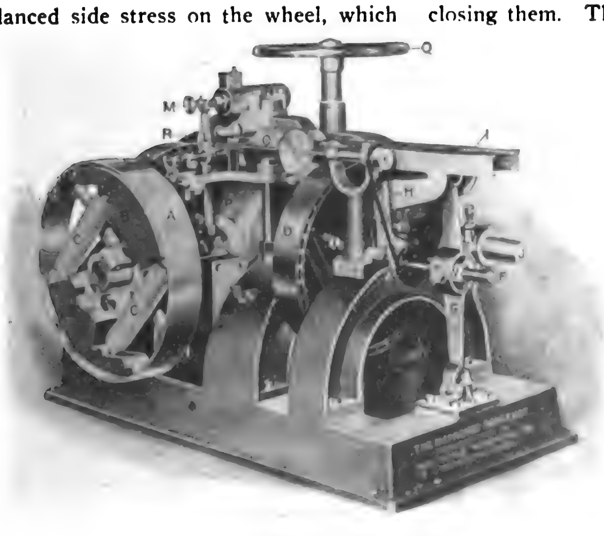

FIG. 43.—"IMPROVED" GOVERNOR.

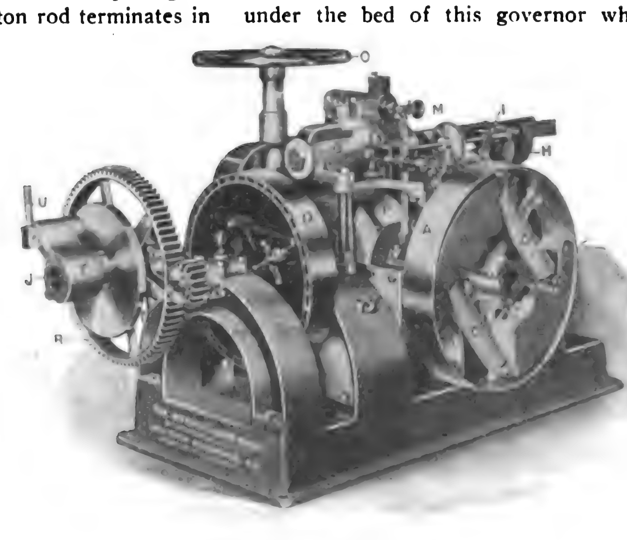

FIG. 44.—"IMPROVED" GOVERNOR.

wheels operate under low head, or where there is no water available under high pressure, a type of governor is used in which the piston is moved by oil under pressure.

Fig. 46 shows the "Type D" governor, which operates with oil under pressure. It

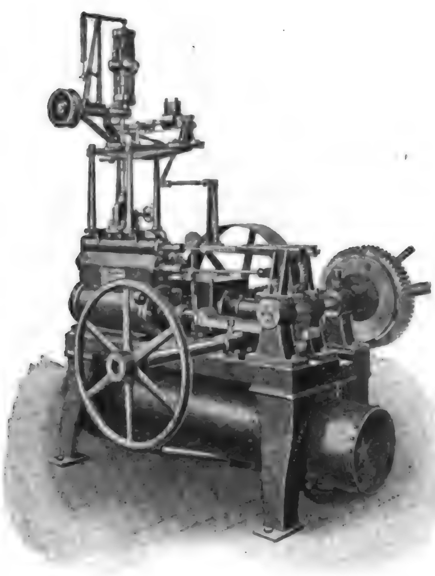

FIG. 46.—"TYPE D" LOMBARD GOVERNOR.

will be observed that under the bed of the governor is a cylindrical tank. This is divided into two parts by a tight partition, the location of which may be seen from the row of rivet heads. The larger part of the tank shown to the left in Fig. 46 is about half full of oil. The upper half of this pressure tank contains air under about 200 pounds pressure to the square inch. The smaller end of the tank shown to the right in Fig. 46 contains a vacuum. The pressure and vacuum are said to be constantly maintained by a pump located on the farther side of the bed of the governor and driven by the larger pulley shown, which is belted so as to slowly rotate all the time the governor is in operation. When the governor piston moves the water-wheel gates it is because oil from the pressure tank is let in on one side of the

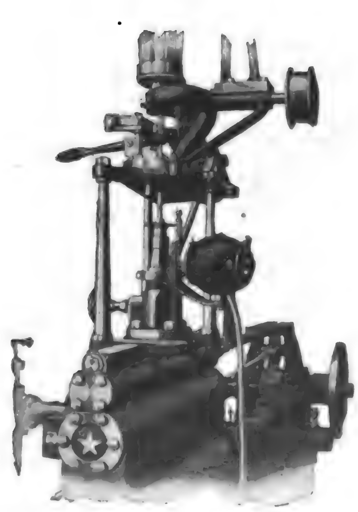

FIG. 47.—MECHANISM ON TOP OF GOVERNOR.

piston; simultaneously the oil on the other side of the piston is vented into the vacuum tank, whence it is immediately pumped into the pressure tank. Fig. 47 shows the mechanism on the top of one of the governors; through which the governor is made to open or close the water-wheel gates when the speed tends to change. All of the governors are fitted with practically the same top, the action of which is as follows: The pulley shown in Fig. 46 is belted directly to the water-wheel shaft and drives the governor balls which, when rotating at normal speed, stand out considerably from the axis of rotation. The mechanism is such that as the balls spread out under the action of centrifugal force they depress the top plate

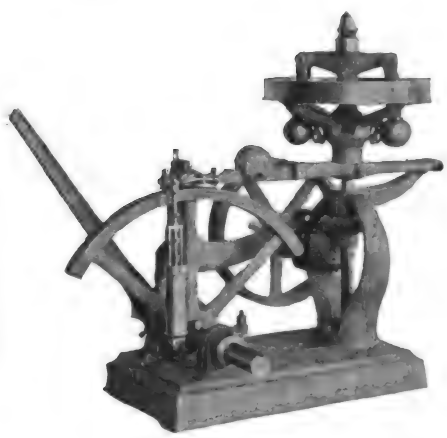

FIG. 48.—REPLOGLE GOVERNOR.

into which the flat springs supporting them are inserted. This top plate is attached to a rod which passes down through the hollow vertical shaft carrying the balls, and terminates in a small vertical piston valve located behind the hand-wheel shown near the bottom of the illustration. It will be evident therefore that as the balls fly out under the influence of increased speed they will depress the piston valve, and, conversely, as they travel inward when the speed becomes below normal, they will lift it. The valve stem or rod referred to is of such length that when the balls are in the position due to normal speed the valve is closed; but the moment the speed becomes above or below normal the piston valve is said to admit oil or water, to one side or the other of the main piston of the governor,

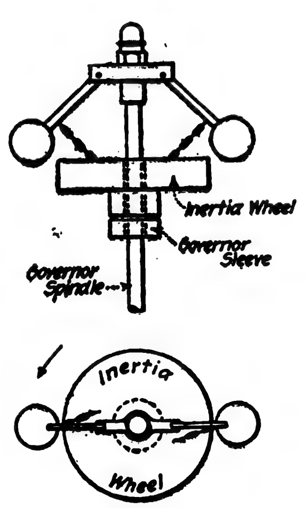

FIG. 49.

causing it to open or close the water-wheel gates. As the rotating balls are claimed to be exceedingly sensitive and as the piston valve has a very small lap, the least change in speed of the water-wheel is said to cause the governor to open or close the water-wheel gates.

There are several types of Replogle governor (built by The Replogle Governor Works, Akron, Ohio), of which three are illustrated by Figs. 48 to 52 inclusive. Fig. 48 shows the simplest form of governor, in which the governor balls raise and lower the horizontal arm pivoted to the extension at the right of the frame. The free end

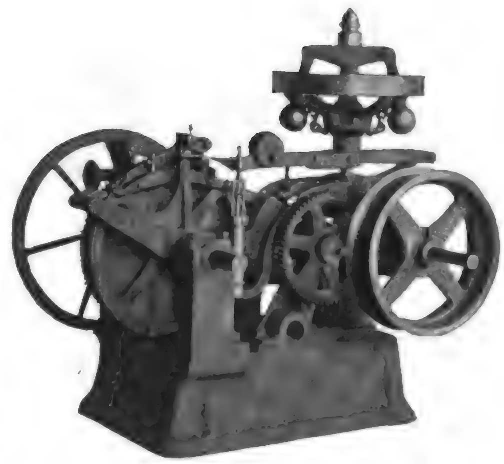

FIG. 50.—REPLOGLE "DUPLEX" GOVERNOR.

of this arm carries a spring finger which swings a double-ended pawl to and fro; one end of the pawl, when depressed, engages one set of ratchet teeth on the segment keyed to the gate shaft, and the other end engages the reverse set of ratchet teeth on the same segment. The double pawl is pivoted to the upper end of a lever which is continuously oscillated by a cam on the governor pulley shaft. When the governor arm is lifted, the left-hand end of the pawl engages its ratchet and moves the segment, step by step, to the left, closing the water-wheel gate, or deflecting the nozzle, as the case may be. Contrary mo-

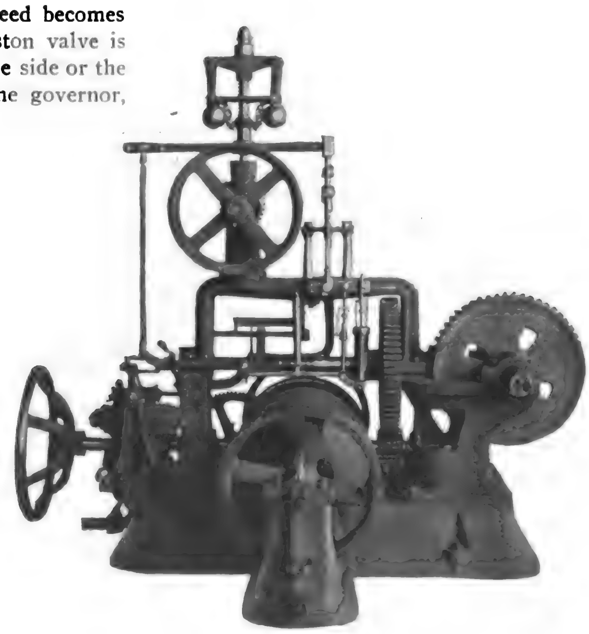

FIG. 51.—REPLOGLE DIFFERENTIAL GOVERNOR.

tion of the governor arm produces the contrary result, of course. An interesting feature of this governor is the arrangement of the governor balls and an inertia wheel which surrounds the ball arms. Instead of

being rigidly linked to the sliding collar on the governor spindle, the ball arms are connected by short chains to the inertia wheel; this wheel is entirely loose on the governor spindle and its hub forms the sliding collar which raises and lowers the horizontal arm; this arrangement is shown diagrammatically in Fig. 49. Should a sudden increase in speed occur, the governor balls will be thrown outward, of course, raising the inertia wheel and its collar, but this action is not instantaneous and it is anticipated by the action of the inertia wheel. When the speed changes, the wheel lags behind the governor spindle momentarily and thereby increases the slant of the chains connecting it with the ball arms; the result is the raising of the inertia wheel and checking of the turbine speed before the centrifugal force of the governor balls has acted to and overcome their inertia.

In the "Duplex" Replogle governor, Fig. 50, the governor balls control a double-ended pawl, as in the preceding type, but this pawl instead of operating the gate shaft, shifts a pivoted cam back and forth; this cam when moved over to one end of its travel raises one of the gate-operating pawls out of reach of the segmental ratchet on the gate shaft; when moved in the opposite direction, it releases the pawl just mentioned and lifts the opposite pawl away from its ratchet; in the middle position, both pawls are lifted away from the ratchets on the segment. The gate-operating pawls are pivoted to a lever which is oscillated from the governor pulley shaft. This governor is adapted for heavier work than the one first described.

The differential governor shown by Fig. 51 is designed for use with large power units and is capable of exerting 15 horse-power on the gate shaft. This embodies the inertia feature already described but in modified form. The governor balls raise or lower the usual form of sliding collar by chains, and the collar, through a system of links and levers, shifts a spherical clutch axially so as to contact with one or the

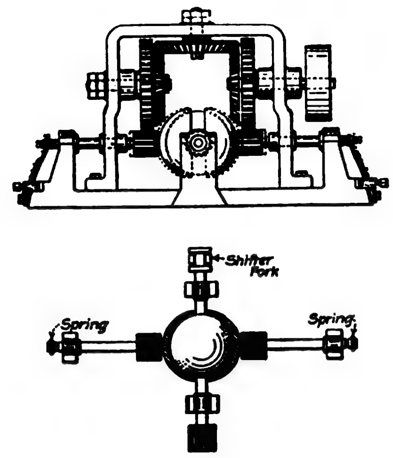

FIG. 52.—CLUTCH OF REPLOGLE GOVERNOR.

other opposite edges of friction cups surrounding the ball and driven by gears from the main shaft. This arrangement of the clutch is shown conventionally by Fig. 52. The hemispherical cups are mounted on short shafts which are driven in opposite directions and are also pressed toward the clutch sphere by springs at each end. The governor mechanism shifts the sphere axially by means of the pawl and ratchet mechanism on the left of the illustration; when the sphere is at one extreme of its axial travel, it is driven in one direction by the two cups; at the other end of its travel it is driven in the opposite direction; at all intermediate positions except the exactly central one, it is driven at speeds which become slower as it approaches the center of its axial travel, and it comes to a standstill at the center. The shaft on which the clutch ball is keyed is geared to the gate-shaft through the spur and bevel gears shown on the right in Fig. 51. All of the Replogle governors are equipped with a compensating device, termed by the builders a "relay releasing cylinder," which cuts the governor out of action after a predetermined period of operation and prevents over-running and hunting. The company also builds a type of governor intermediate between the "Duplex" and the differential types shown in Figs. 50 and 51.

Fig. 53 illustrates the Woodward compensating type of water-wheel governor, built by the Woodward Governor Company, Rockford, Ill. A double friction clutch is also used in this governor, but it is of the bevel type similar to that used in some friction-clutch pulleys. The power shaft of the governor is driven by belt and from it the governor spindle is belt-driven. The power shaft carries a double-coned friction wheel made of compressed paper; on each side of this wheel is a cup-shaped friction wheel mounted loosely on the shaft and carrying a pinion at its center. The friction cups or "pans," as they are termed, are prevented by collars from axial motion and the power shaft is moved axially by the controlling mechanism so as to put the friction wheel into contact with one of the embracing "pans" or out of contact with both, according to the requirements. The friction "pans" are geared to the gate shaft oppositely, so that one of them closes the gate and the other opens it. Fig. 54 shows the controlling mechanism. The horizontal disc at the left of the picture is driven continuously by spiral gears and a belt from the

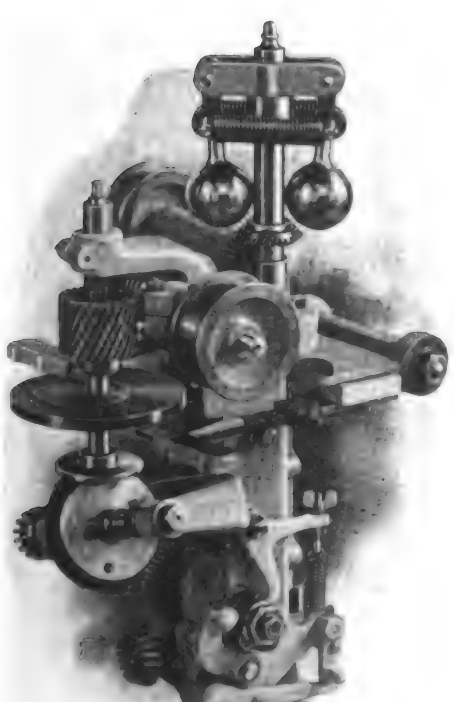

FIG. 54.—WOODWARD CONTROLLING MECHANISM.

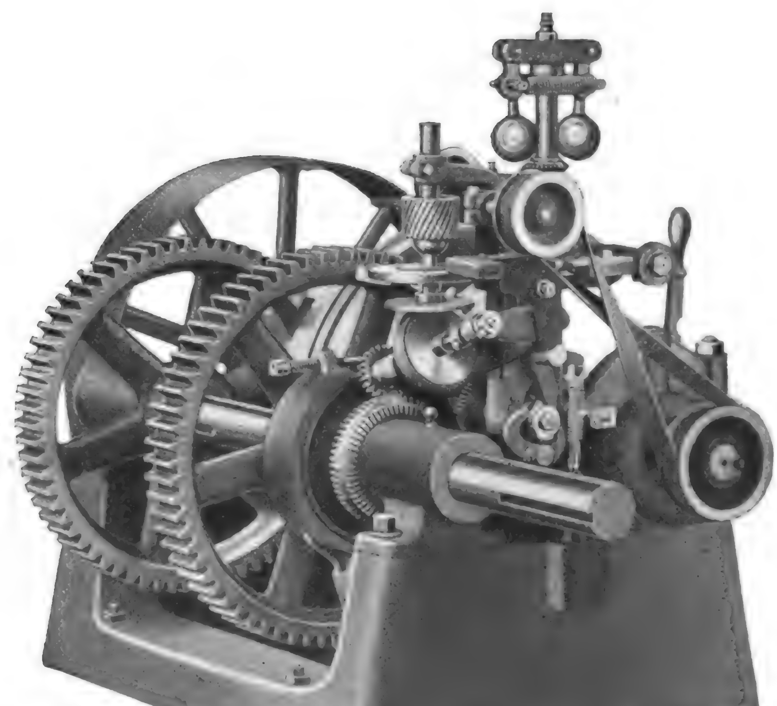

FIG. 53.—WOODWARD WATER-WHEEL GOVERNOR.

power shaft; this disc has a cam on the upper face and one on the under face. The governor balls merely put one of two fingers into engagement with the corresponding cam on the horizontal disc; these fingers are actuated by their respective cams, one

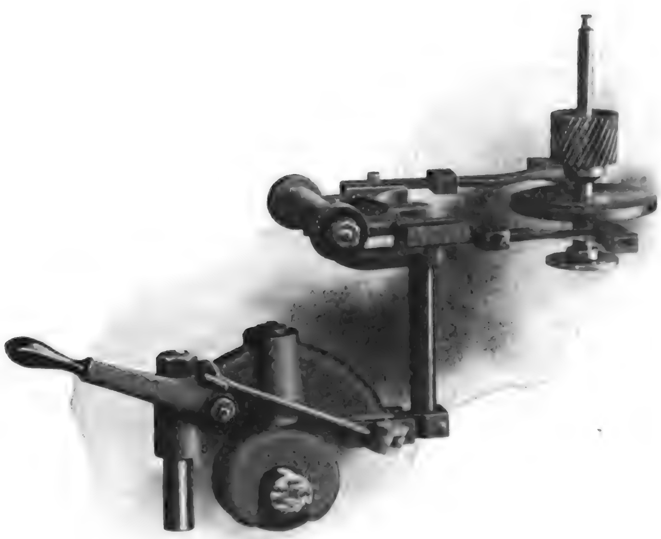

FIG. 55.—DETAIL OF WOODWARD CONTROLLING MECHANISM.

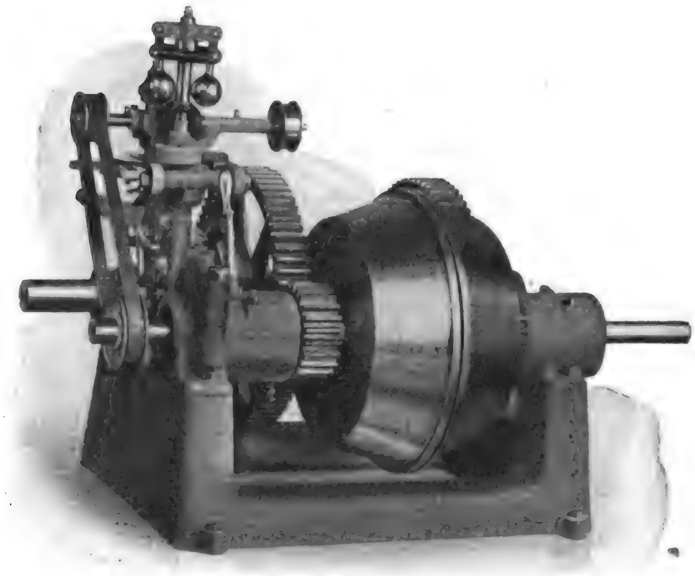

FIG. 56.—WOODWARD WATER-WHEEL GOVERNOR; REAR VIEW.

to force the power shaft in one direction (axially) and clutch one of the friction "pans" and the other to produce the contrary results. On the same spindle with the horizontal cam disc is mounted a friction disc which rests upon the edge of a friction wheel journaled in a yoke set diagonally; this is clearly shown in both illustrations. The hub of the latter wheel is threaded to fit loosely a screw-thread on the diagonal spindle; this spindle is driven by gears from the gate shaft, so that it rotates one way when the gate is being closed and the other way when the gate is opening. The normal position of the tilted friction disc is at the center of the horizontal disc; if, for example, the governor balls set the upper cam finger against the cam and start the gate shaft in whichever direction this action produces, the diagonal spindle geared to the gate shaft will be revolved in such a direction as to draw the tilted friction wheel downward along its screw, lowering the horizontal friction disc and thereby taking the cam disc out of reach of the upper cam finger and releasing the friction "pan" driving the gate shaft. The threaded spindle comes to a stop; of course, with the gate shaft, and the tilted disc is then run back on the stationary threaded spindle to the center of the horizontal disc by the continuous rotation of the latter. This compensating arrangement is to prevent overrunning and hunting.

The governor built by the Sturgess Governor Engineering Company, West Troy, N. Y., is of the hydraulic type, *i. e.*, the wheel gate is operated by hydraulic pressure instead of by power derived from the turbine itself. Instead of using a cylinder and piston of the ordinary type, however, an arrangement based on the general principle of the rotary engine is employed, in which, however, the rotary part makes only 0.87 of a revolution. Fig. 57 shows this governor. On the gate shaft is mounted a rotary piston which is enclosed in a cylindrical chamber; this chamber constitutes the lower part of the machine. Immediately above this chamber are the valve chest and valves controlling the motion of the rotary piston. The main valve is of heavy, substantial construction and is operated hydraulically, its motion being controlled by a pilot valve mounted in the center of it and adapted to open ports in the main valve, as indicated in the sectional view, Fig. 58. The pilot valve is actuated by a centrifugal governor of the ordinary shaft type, which revolves loosely on an extension of the rotary piston shaft and is belt-driven through the medium of the expansible pulley shown on the extreme right, the power for driving being derived from the main turbine shaft.

On top of the valve chest is mounted a dash-pot, which is adapted to slide on its seat in a direction parallel with the motion of the main valve. The tendency of this dash-pot is to remain in the center of its travel, as indicated in Fig. 58, irrespective of the position of the piston within. Upon variation of the load the centrifugal governor operates the pilot valve in the proper direction to effect the further opening or partial closing of the turbine gate, according to the necessity of the case. As soon as the gate shaft begins to move, the cam near

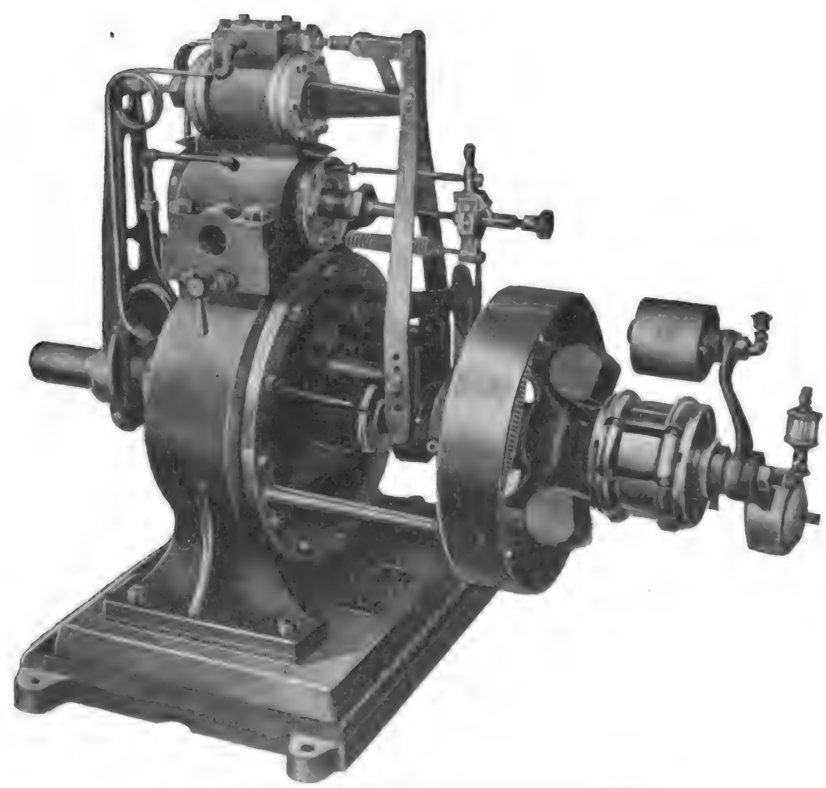

FIG. 57.—STURGESS WATER-WHEEL GOVERNOR.

the left-hand end of that shaft operates the vertical lever, which in turn forces the piston of the dash-pot in one direction or the other, according to the direction in which

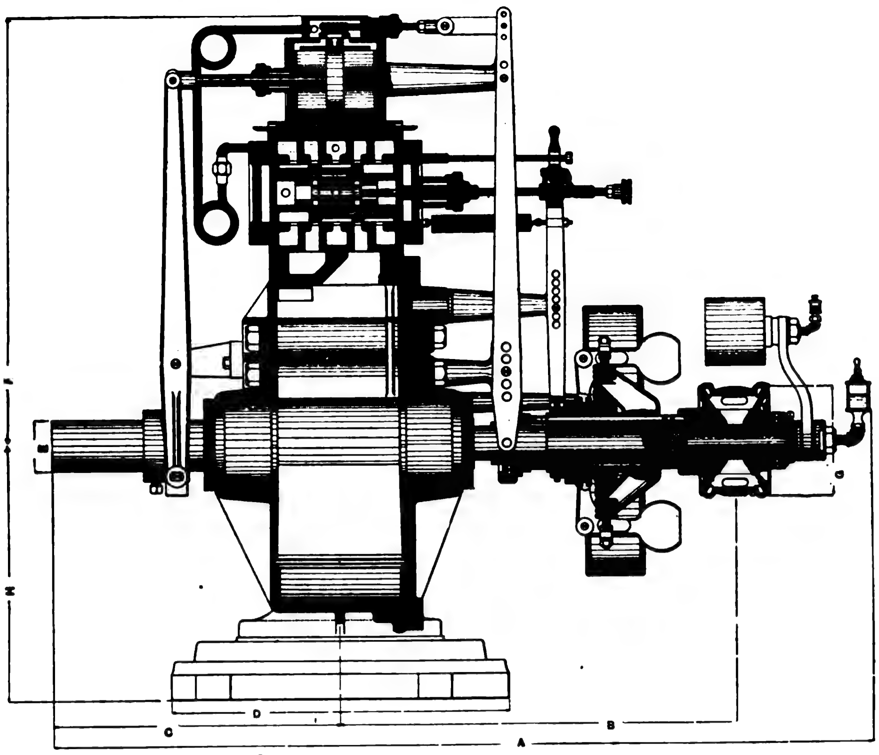

FIG. 58.—SECTION THROUGH STURGESS GOVERNOR

the gate shaft has moved. As the dash-pot is filled with water (or oil) the movement of its piston causes the dash-pot itself to slide to the right or left, moving the long lever on the right-hand side one way or the other; the lower end of this lever is connected through a sliding collar to the expansible pulley, which is expanded by movement of the lever in one direction and contracted by movement in the opposite direction. Connection is made between the main valve chamber and the valve chest of the dash-pot by means of a small pipe having two complete turns in it so as to make it flexible and allow it to follow the movements of the dash-pot to the right or the left. The operation of the governor is as follows:

If there has been an increase in load, for example, the speed of the turbine will be checked, and the centrifugal governor will move the pilot valve in such a direction as to cause the turbine gate to be opened wider by the rotary piston. As soon as the gate shaft begins to move, the cam on the left throws the dash-pot piston to the right, and this causes the contraction of the expansible pulley, which slightly increases the speed of the centrifugal governor, compensating for the drop in speed by the turbine shaft and counteracting the tendency of the governor to carry the pilot valve to the extreme limit of its travel. The motion of the dash-pot to the right causes its slide valve to uncover the ports, admitting pressure to the left of the piston and relieving pressure on the right of the piston. This checks any further advance of the dash-pot itself, and as soon as the gate shaft comes to a stop the dash-pot is gradually returned to its mid position by the pressure on the left-hand side of its piston. In returning to the central position, the dash-pot increases the diameter of the expansible pulley; this would of itself reduce the speed of the centrifugal governor and further affect the valve, but, as the result of the previous movement of the gate shaft, the turbine speed will have picked up and the increase in its speed will counteract the increase in the size of the expansible pulley and maintain the speed of the centrifugal normal. This arrangement is said to give an extreme-

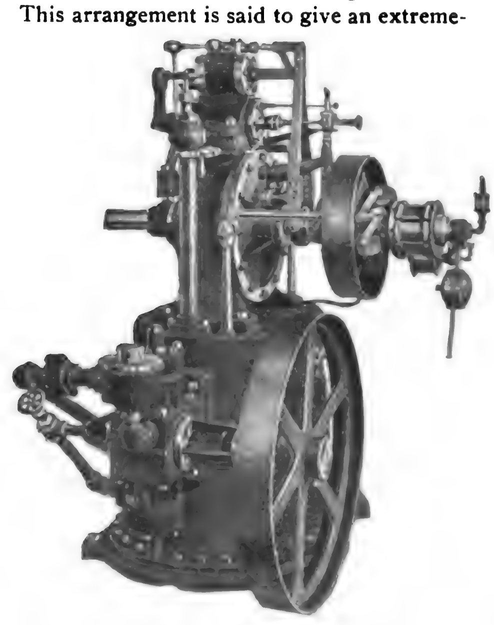

FIG. 59.—SELF-CONTAINED STURGESS GOVERNOR, PUMP AND TANK.

ly sensitive gate control and at the same time to prevent overrunning and "hunting." The rotary piston has a range of 0.87 of a revolution, so that its shaft can in most cases be coupled directly to the gate shaft of the turbine. Of course, when the gate shaft must take more than 0.87 of a revolution, the connection between the governor shaft and the gate shaft is made by means of gears of the proper ratio. The hydraulic pressure for the operation of the valves and the rotary piston is obtained from the penstock, or some similar head of water, whenever this is practicable; when it is not, a pump and receiver are supplied, and oil is used as the working fluid for the governor.

Fig. 59 illustrates the Sturgess self-contained governor, oil tank and pump, designed for places where space is limited. The tank forms the base of the governor and the pump is bolted to the side of it. The pump is a double-cylinder single-acting machine, the cylinders being coaxial and the two plungers being bolted to a common yoke.

THE ENGINE BUILDERS' ASSOCIATION.

This Association held its annual meeting in New York, December 9 and 10, the sessions being held at Sherry's Hotel, which has become the usual headquarters for these occasions. President C. A. Gates occupied the chair.

The papers read at the public sessions were on "Costs," by C. M. Lauer; "The Steam Turbine," by F. C. Bates; "Employers' Associations," by Charles L. Eidlitz, and "Salesmanship as an Applied Science," by R. U. Conger.

Mr. Lauer in his paper recommended the basing of manufacturing costs on charges for the time put in by the men and the machinery separately, making the man-hour charge 50 per cent greater than the rate actually paid the man, and basing the machine-hour charge on the investment, proportion of the shop floor-space occupied, wear and tear on the machine, and other factors actually entering into the cost of operating the machine, excepting the operator's wages, of course. The paper was discussed briefly by Messrs. John E. Sweet, W. M. Taylor, John Dick, W. D. Forbes and the author.

Mr. Bates' paper was a brief exposition of the principles of steam turbines, including some historical references, and a description of the salient features of the Parsons, De Laval, Rateau and Curtis turbines, the latter naturally receiving the most elaborate treatment; in fact, the description of the Curtis machine was very complete. The author also pointed out the advantages in generator construction that the speeds of the Curtis type of turbine conferred. The paper was discussed very slightly by Messrs. Dick, F. R. Low, W. M. Taylor and C. R. Vincent.

Mr. Eidlitz's paper was full of hard common sense and humor, and elicited much applause and merriment. The author urged that an association of employers must be led by men fitted for their responsibilities, regardless of their positions in the commercial world and any petty jealousies on the part of their business competitors in the association, and pointed out that loyalty and open purses are absolutely indispensable for success, as demonstrated time and time again by the labor unions. There was no discussion of the paper, but Messrs.

Dick and Taylor expressed their cordial appreciation of it.

Mr. Conger did not read a "paper;" he delivered an extremely interesting address without notes, but one for which he was evidently well prepared. He analyzed salesmanship, which, he declared, was practically a science, and advanced some attractive arguments as to the essential qualifications of a successful salesman.

After the regular programme was concluded, Prof. Sweet, who had been delegated to go to Washington with Messrs. William Kent and W. M. McFarland to oppose the adoption by the Government of the metric system, reported that he and his colleagues had been unable to get the House Committee to agree on a report, and that the matter had, therefore, been left in *statu quo*. He thought his committee's arguments had prevented the Government from making a favorable report, but the matter would undoubtedly come up again next year. He also made some remarks concerning the proposed substitution of the metric system for the English system in this country, and fell into the customary anti-metric error of referring to the contemplated governmental legislation as "compulsory."

The public session adjourned *sine die* at the close of Prof. Sweet's remarks. At the executive session held the following day these officers were elected for the ensuing year:

C. A. Gates, re-elected president; Thomas C. Wood, vice-president; Arthur L. Merriam, treasurer; N. B. Payne, secretary. Council: Walter C. Kerr, S. F. Bagg, N. B. Payne, C. A. Bonsall, H. C. Nichols and J. I. Lyle.

Abstracts from Foreign Contemporaries

Heating of Underground Three-Phase Cables.—Dr. R. Apt and C. Mauritius contribute an article to a recent issue of the *Elektrotechnische Zeitschrift* on the heating of underground three-phase cables. The cables upon which the first tests were made were built for voltages up to 1000, and had fiber insulation. Provided that not more than two of these be placed close together in the ground and the temperature shall not rise more than 25 degs. C., the maximum currents to be allowed for different cross-sections are given in the following table:

Sq. mm.	Amperes per phase.	Maximum current per mm. cross-section.
(3X 6)	(50)	(8.33)
3X 10	65	6.5
3X 16	85	5.31
3X 25	110	4.41
3X 35	135	3.86
3X 50	170	3.4
3X 70	205	2.93
3X 95	245	2.58
3X120	280	2.33
3X150	320	2.13
3X185	365	1.97
3X210	395	1.88
3X240	430	1.79
3X280	470	1.68
3X310	500	1.61

These values should never be exceeded. Cables built for a maximum voltage of 6000 with paper insulation were then tested. With a maximum allowable temperature rise of 25 degs. C. the maximum currents allowed are as follows:

Sq. mm.	Amperes per phase.	Maximum current per mm. cross-section.
(3X 6)	(50)	(8.34)
3X 10	60	6.00
3X 16	73	4.57
3X 25	90	3.60
3X 35	108	3.09
3X 50	130	2.60
3X 70	155	2.22
3X 95	185	1.95
3X120	210	1.75

Less current per cross-section is allowed for high tension than for low tension cables. The highest permissible current depends upon whether the increased temperature acts on the insulating material so as to decrease the perforation voltage. The fact that with increase of temperature the insulation resistance decreases is of little moment, since a high insulation resistance is no longer considered to have anything to do with the quality of the cable. From tests made by the authors it was shown that the perforation voltage changes with increases in temperature, having a maximum value for fiber insulated cables, the position of the maximum depending upon the material with which the cable is impregnated. With Gutta Percha cables the perforation voltage decreases continuously with increasing temperature. The maximum value in fiber insulated cable is, however, never reached in practice.

Lightning Conductors.—At the second general meeting of the Birmingham Architectural Association, a lecture on "Lightning Conductors" was delivered by Sir Oliver Lodge. In the course of his remarks, he stated that a copper conductor was not so good as an iron one. It did not damp out the oscillations; it let the current down too suddenly and was liable to side flashes. A small iron wire was ample protection, so long as the wire lasted. The lightning might dissipate the wire, but by the time the flash was over the conductor had achieved its purpose. It was better to have a number of cheap conductors than one or two expensive ones. But if one wanted to be absolutely immune from lightning—and there were cases when it was desirable, such as in the case of a powder magazine, or a guncotton factory—one could be so by providing a complete metallic enclosure like a banker's strong room. The only possible way to damage such a building would be for the lightning to be strong enough to melt it. The building might retain the charge, however, so that it would be as well to have sky and roof terminals. Sir Oliver then proceeded to demonstrate his lecture with a number of interesting experiments.

Starting and Regulating Resistance.—MM. Lindenstruth and O. Foster recently communicated to *L'Eclairage Electrique* an interesting article on some modern types of cheap and compactly built metal resistances for starting and regulating purposes. The gist of their communication is as follows: For resistances, which are required to absorb but small energies, the old design of spirals of resistance wires, suitably assembled, leaves little to be desired. If, this is not the case and there is danger of the coils coming in contact with each other, the spirals are often stiffened by a rod of slate or a tube of asbestos placed inside the coil. It is stated as a general rule that rheostats for continuous service should be designed with a view to perfect ventilation, while rheostats for intermittent use are best designed with a metal cover, which quickly absorbs and slowly dissipates the heat given off by the resistance. Fig. 2 shows a very compact pattern of resistance for continuous service, suitable for small currents. The resistance wire passes spirally from one of the grooved porcelain pieces, *b b'*, to the other, these two porcelain pieces being held apart by a plate, *a*, of iron, slate or asbestos. Iron is preferred because of its strength and its ability to dissipate heat rapidly. Iron plates are also used in the design shown by Fig. 3. Fig. 1 shows another type of resistance, in which the ac-

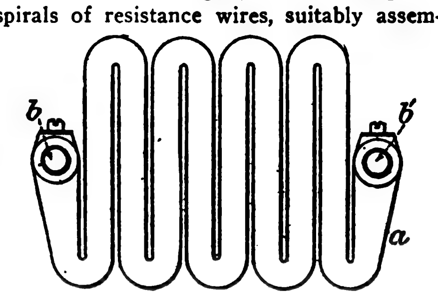

FIG. 1.

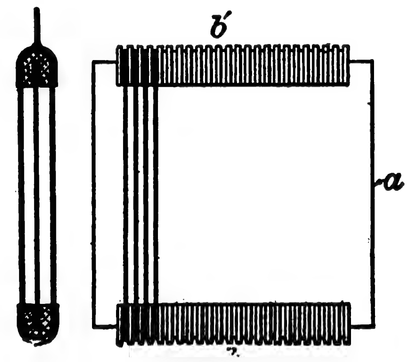

FIG. 2.

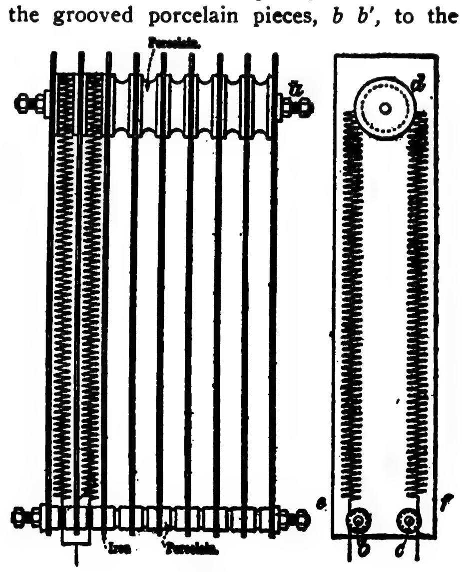

FIG. 3.

tual resistances are usually cast. For heavy currents the type shown in Figs. 5, 6 and 8 is preferred. As shown in the sketch, Fig. 5, the resistance takes the form of metal strips, *b*, which are clamped at their upper ends to a series of cross-supports, *a*. The strips are mounted zig-zag, and are kept in position by the arrangement indicated in Fig. 8. A resistance designed upon these lines has been used for regulating the speed of a three-phase 1500-h.p. 6000-volt motor. The speed limits are 125 and 150 r.p.m., and the regulation is obtained by inserting resistance in the stator circuit. Fig. 4 shows a design of resistance for intermittent use. The outer tube is of iron and lined with asbestos. The resistance coil is introduced while still wound on the mandril, but when the latter is withdrawn the coil expands and presses firmly against the asbestos lining. Subsequently the tube is filled with a suitable cement. Another form often used consists of a spiral of a long, flat resistance strip wound like the spring of a clock, asbestos or mica being wound together with the metal strip so as to separate the individual turns. Several resistances constructed in this way may be connected as shown in Fig. 9. A similar but more open construction is shown in Fig. 7.

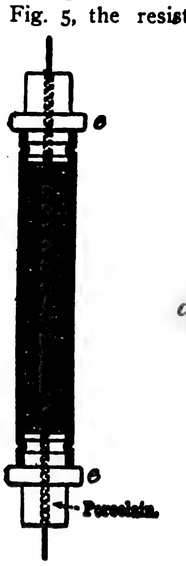

FIG. 4.

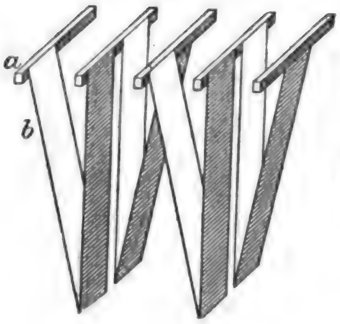

FIG. 5.

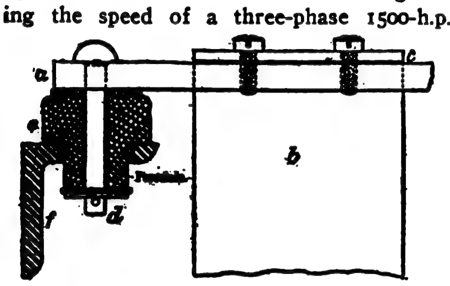

FIG. 6.

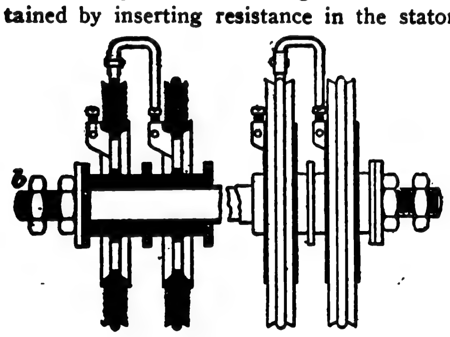

FIG. 7.

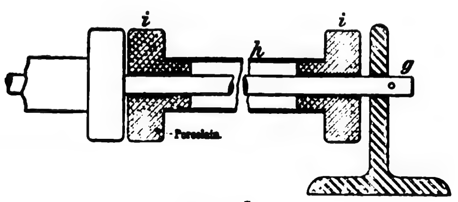

FIG. 8.

Maximum Current Permissible in Direct-Current Cables.—Dr. H. Kath contributes to the *Elektrotechnische Zeitschrift* the report of the committee appointed by the Union of German Electricity Works and by German cable manufacturers which

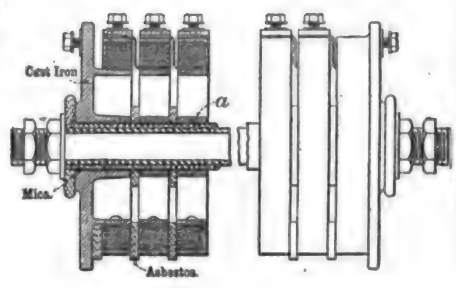

FIG. 9.

has been adopted by the German Association of Electrical Engineers. The committee gives the following formula for the maximum current, which may be allowed in single direct-current cables:

$$J = c \sqrt{\frac{q\,t}{\log \dfrac{4\,l}{d}}}$$

In this formula J is the maximum current permissible; c is a constant, the value of which was found from numerous experiments to be 11.55; q is the cross-section of the copper core in sq. mm.; t is the increase in temperature in degrees Centigrade of the cable core, which is taken at 25 degs. in calculating the following figures; l is the depth in mm. below the surface, where the cable is laid and is taken as 700 mm. in the following figures d is the diameter in mm. of the copper core. The following table gives the figures for direct-current cables laid in earth, the first column giving the cross-section and the second column the maximum current permissible with a difference of potential of 700 volts.

Cross-section in sq. mm.	Amperes.
16	140
25	175
35	215
50	260
70	315
95	370
120	420
150	475
185	530
240	615
310	705
400	810
500	920
625	1040
800	1190
1000	1350

The current given in the table should not be exceeded, and the figures hold good as long as there are not more than two cables in close proximity in the earth. Neutral wires are not considered as cables. If the considerations for the dissipation of the generated heat be unfavorable or if a great many cables are crowded in the earth, it is recommended to make the permissible current three-fourths the value given above.

Current Regulator.—A form of improved apparatus for automatically regulating the current in electric lighting installations is shown diagrammatically by Fig. — herewith, taken from *Engineering* of London. In the sketch, *E* represents a motor used to regulate the field excitation of the dynamo *D*. The winding of the motor is composed of two separate sets of coils, *A* and *V*. The set, *A*, is supplied with current from the battery, *B*, and the set, *V*, is supplied with current flowing in the opposite direction to that in the set *A*. By the influence of these two coils the motor, *E*, whose armature is connected with the field coils of the dynamo, *D*, is caused to shift the controlling lever, *H*, of the resistance, *R*, for regulating the field excitation of the dynamo, in accordance with the varying speed of the dynamo, and the varying number of lamps in circuit until the two coils, *A*, *V*, balance each other in their magnetizing action. Consequently, the battery, *B*, will be supplied with current which will be, under all conditions, in a determined proportion to the number of lamps switched on. For the purpose of safeguarding the lamps

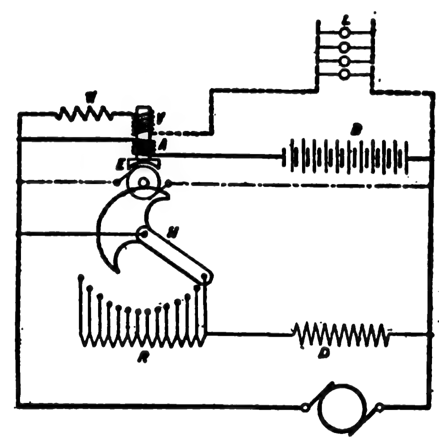

FIG. 10—CURRENT REGULATOR.

against the increase in potential which is produced at the terminals of the battery, *B*, and is due to the action of the internal resistance of the latter, according to the current strength supplied to the battery, there is included in the conductor leading to the lamps a resistance, *W*, which produces a fall of potential at the lamps, *L*, of such an amount that by its means the increase of potential that takes place at the terminals of the battery, according to the strength of the charging current, is rendered harmless, and the lamp potential remains constant in all cases.

Oil for Transformers, Switches, Etc.—E. K. Scott contributes to the London *Electrical Review* a short article on oil for transformers, switches, etc., based principally upon American practice. There are various methods of drying, but perhaps the best one is to place the oil in a large tank having a resistance coil suspended in the center. After the current has heated up the oil, air is blown through it from a motor-driven compressor, the air having been first thoroughly dried by passing it over chloride of lime. As the small bubbles pass upward through the oil they take up any moisture that may be present. In the case of a very

large tank, it is as well to also agitate the oil mechanically, so as to insure all of it coming into contact with air. After drying, a flashing test is made, and this, of course, varies according to the voltage to be employed. It may be taken, however, that no oil is considered satisfactory which will not withstand at least 30,000 volts alternating between two flat surfaces 1½ in. in diameter and 1-5 in. apart. Oil is an absolute necessity for high-tension switches. In very cold weather the oil may become thickened. As a cure for this the General Electric Company recommends tetrachloride of carbon with oil.

Ball Bearings for Electric Motors.—In order to improve the efficiency of electric motors, an English company has introduced small motors fitted with ball bearings of an improved type, whereby the losses due to friction are reduced, great saving is effected in the consumption of oil, and the space occupied is less than for motors fitted with ring lubricated bearings. Instead of filling the whole space between the inner and the outer rings with balls, as hitherto, a smaller number is provided, the spaces between the balls being fitted with springs, as shown by Fig. 11 herewith

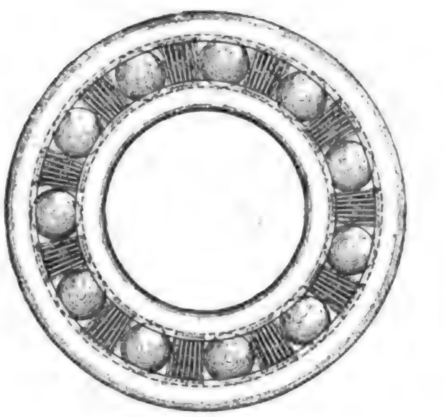

FIG. 11.—BALL BEARINGS FOR MOTORS.

taken from the *Electrical Engineer* of London. If, in consequence of the bend of the shaft, there is a tendency for the outer ring to get out of true with the inner ring, the variation in the speed of the balls is counterbalanced by the action of the springs, so that the balls will not be damaged. A further advantage of the design is that the springs are filled with felt, which forms a rotating lubricating machine. Easy access to the balls is provided for purposes of inspection.

Measuring Magnetomotive Forces.—London *Electrician* contains an illustrated description of Rudolf Goldschmidt's method of measuring magnetic potential drop, which was devised to test actual steel field magnets which were suspected of being faulty in quality and casting. The principle is as follows: To measure the magnetic potential drop between the points *a* and *b* in the yoke of a direct-current machine, two laminated iron cores, *AC* and *BD*, are placed on *a* and *b*, respectively, in the manner shown, the gap, *CD*, being from ¾ in. to ⅞ in. By this arrangement a small magnetic shunt is formed to the yoke which will take up a small amount of the magnetic flux. Point *C*, for instance, will indicate north polarity, point *D* south polarity, and a small compass needle placed between *C* and *D* will assume a position pointing with its south pole to *C*. The coils, S_1 and S_2,

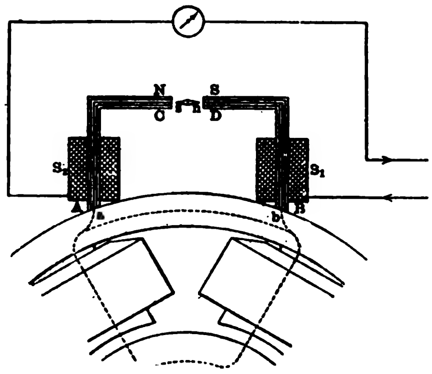

FIG. 12.—MEASURING MAGNETOMOTIVE FORCES.

are so excited as to counteract the magnetic potential between *a* and *b*. If the ampere turns, S_1 and S_2 are increased sufficiently to overpower the magnetic force of $a — b$, then the flux in the magnetic shunt would reverse, the polarity of *C* would become north and the polarity of *D* south, and the compass needle

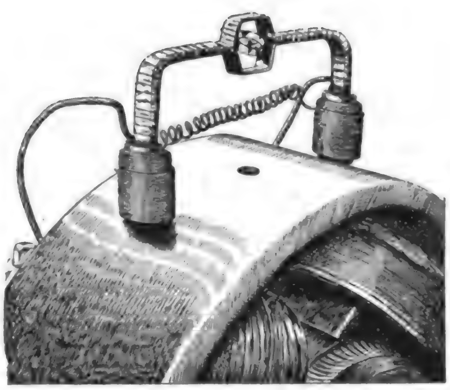

FIG. 13.—MEASURING MAGNETOMOTIVE FORCES.

would point in the opposite direction. If the current in S_1 and S_2 be so adjusted that the compass just begins to move from one position to the other, the magnetomotive force of the coil is equal to the difference of potential between *a* and *b*, and thus represents directly without any further calculation the amount of ampere turns required to drive the flux through the yoke of the machine. Fig. 13 shows the method applied to the yoke of a direct-current machine, and

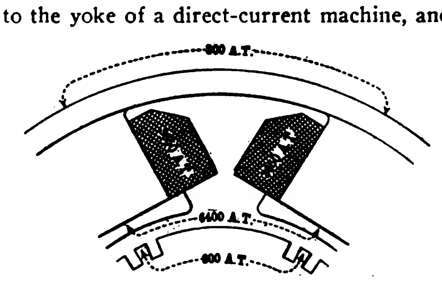

FIG. 14.—MEASURING MAGNETOMOTIVE FORCES.

Fig. 14 shows a diagrammatic sketch of the magnetic circuit with the figures inserted as they were actually determined by the apparatus. To shield the compass needle from the influence of undesirable stray lines, the compass may be surrounded by a small iron box, as shown. Other applications are as follows: Measuring the drop for the different yokes and parts of a direct-current machine so as to detect irregularities and blow-holes in the iron; getting the full magnetic curves of the armature teeth of electrical machinery; detecting bad joints in any part of the yoke of direct-current machines. The method may also be applied to measuring the direct-current in a conductor, say, a feeder cable, without inserting the ammeter or cutting the cable in any way. The author states that the method is sufficiently accurate for all practical purposes.

Distribution of Electrical Energy—At a recent meeting of the British Institute of Civil Engineers, J. F. C. Snell presented a paper on "Distribution of Electrical Energy," which is abstracted in *Engineering* of London. After dealing with the limits of pressure, as defined by the Board of Trade, and the results of the work of the Engineering Standards Committee in settling upon standard periodicities, the systems of supply are more thoroughly criticized, and the single-phase system is set aside as being inapplicable for general supply, as is also the direct-current high-tension system. The author is of the opinion that the distributing systems which are likely to be adopted in the future are:

1. Direct-current, two or three-wire, for small districts.
2. Single-phase high-tension for railways.
3. Two-phase high-tension generation and low-tension distribution (for existing single-phase systems of general supply).
4. Three-phase high-tension generation and direct-current low-tension distribution (for existing direct-current systems in large districts, and for railways of short length).
5. Three-phase high-tension generation and low-tension three-phase or six-phase distribution (for entirely new and large districts).

Diagrams accompanying the paper demonstrate the economical radii of supply by direct current at 500 volts for different loads transmitted and by the high-tension substation method, the result being that above the under-mentioned distances the high-tension method is more economical, viz.:

Kilowatts.	Radius. Miles.
250	1.6
500	1.25
1000	1.06

With regard to the effect of storage at sub-stations, the author believes that storage will be more largely resorted to in the future; and figures are given in support of this view. He then proceeds to discuss the economical limit of pressure for high-tension supply by underground cables; and gives curves to show that for general purposes, in Great Britain, 6600 volts is, approximately, the economical pressure. The effect of the cost of insulation of extra high-tension cables is also discussed. The paper next deals with the cost of overhead transmission of high-tension currents, and reasons for fixing upon a pressure of 20,000 volts in England are given.

Dielectric Strength of Certain Specimens of Mica.—Messrs. E. and W. H. Wilson contribute to the London *Electrician* the results of tests made by them on certain specimens of mica, the object of the tests being to determine the dielectric strength. The method of test was to place each sheet between two circular bronze electrodes, each 1 in. in diameter and 1-16 in. thick, and to raise the difference of potential between them by aid of a transformer until the specimen broke down. The frequency was 55, and the difference of potential was raised by increasing the exciting current of the alternator. Each test was performed as quickly as possible, but in the case of the micas having the higher dielectric strength there was slight local heating due to the electric discharge at the edge of the discs consequent upon the increased density of the electric force produced there by the presence of the mica. In some cases nine specimens of one kind were broken down.

No. of specimen.	Description.	Maximum volts in 10^6 required to puncture. Thickness in millimetres. 0.1	0.2	0.3	1
1	Madras, brown spotted	1.6	1.2	0.9	..
2	Madras, green spotted, A.	1.3	1.1	0.9	..
3	Madras, green spotted, B	1.0	0.75	0.5	0.27
4	Madras, green spotted, C	1.3	1.1	0.94	..
5	Madras, green stained	1.6	1.2	0.95	..
6	Madras, green much stained	1.9	1.3	1.0	..
7	Madras, green clear, B	1.7	1.2	0.95	..
8	Madras, green clear, C	1.7	1.2	0.90	..
9	Madras, green clear, D	2.0	1.3	0.8	..
10	Bengal, spotted	1.1	0.6	0.2	..
11	Bengal, ruby, much stained	1.6	1.4	1.2	..
12	Bengal, white	2.5	1.3	0.4	..
13	Bengal, yellow	2.1	1.4	0.9	..
14	Bengal, ruby, clear	2.1	1.4	0.9	0.72
15	Canada, amber	1.5	1.1	0.8	0.5
16	South America, spotted	1.0	0.6	0.4	..
17	South America, ruby, clear	2.1	1.4	0.9	..

Causes of Explosions in Cast-Iron Steam Valves. —Considerable attention has been given to the subject of cast-iron steam valves, during the past ten years, says M. Sylvain Périssé, in *Le Génie Civil*. The theory has been that, on opening a valve which has been shut for some hours, the condensed water is projected forward by the live steam, and thus produces intense pressure by reason of its momentum, and that the actual rupture is facilitated by the shocks caused by the violent condensation of the live steam when encountering the water. The results of some experiments by Mr. Gurlt, on behalf of the German Government, are given, and these show that when steam at a pressure of 71.1 pounds per square inch encounters cold water, the pressure produced may be as much as 925 pounds per square inch; mention is also made of the violent detonations noticed by Mr. Raymond under somewhat similar circumstances. Three accidents are detailed, one at Villefranche in August, 1897, one at Tourcoing in January, 1898, and one at Vervicq in June, 1898. In all these cases there appears to have been negligence in blowing off the condensation water, and the cause of the accidents is not far to seek. The author then cites two accidents, one in a flour mill at Pornic, and the other in a brewery in Paris, where the cause of the disasters is not so clear, owing to the fact that great care was plainly taken to get rid of condensed water. A detailed account is given of a fatal accident in May, 1901, at an electric station in Paris—an accident which the author was deputed to investigate. In this case the valve was placed 12.6 in. from the top of a vertical pipe, the diameter of which was 6.3 in.; this pipe was joined at the upper end to a horizontal main steam pipe of a diameter of 11.80 in. Drain cocks were provided in the main pipe, but there was sufficient space above the valve to store 1.43 gallon of water. When the accident happened the valve had been closed for eight hours, and, although all precautions were taken and the valve itself opened very gradually, a rupture ensued. By way of accounting for the accident, it is pointed out that when steam under pressure is allowed to expand adiabatically there must be a liberation of energy, and a table is given to show that, with an initial pressure of 14.2 pounds per square inch, 7067 foot-pounds of energy can theoretically be produced by every pound of hot water, while, with an initial pressure of 170.6 pounds per square inch, no less than 54,392 foot-pounds of energy is possible. The author is of the opinion that a small by-pass should be fitted to all valves on a vertical or an inclined steam pipe.

Some Recent Electrical Patents

Tank Float Switch. —Fig. 1 illustrates a simple mechanism for use chiefly in connection with the main switch of a pump motor supplying fluid to a tank or other vessel in which it is desired to keep the level of the fluid between certain high and low limits. The switch is controlled by a float, *N*, which swings a pivoted arm, *G*, to and fro, as the fluid level in the tank (not shown) varies. The arm, *G*, carries a slider, *J*, which is pressed outwardly by the spring coiled around it, and carries a roller, *L*, which travels along the face of an arc-shaped cam, *B*. The switch blade, *F*, is attached to an extension arm of the cam. The sketch shows the switch open; as the fluid level in the tank falls, the float, *N*, is lowered, but the switch is not affected until the roller, *L*, passes the center of the cam-face; as soon as this occurs, the spring, which is gradually compressed by the downward travel of the roller along the cam-face, forces the slider, *J*, outward and shifts the switch arm, putting the blade, *F*, into the jaws. This starts the motor, and the tank is gradually filled again; when the float is lifted far enough to carry the roller, *L*, above the center of the cam-face, the spring opens the switch. It is evident that both the opening and closing of the switch are accomplished with a suddenness that prevents either "tipping" or dragging an arc at the jaws. Patent No. 776,521.

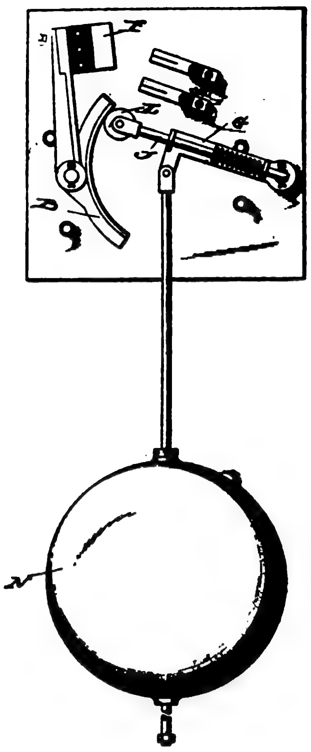

FIG. 1.—TANK FLOAT SWITCH.

Danger Signal for Elevator Gates.—Fig. 2 is a diagram showing in principle the application of a danger signal for elevator gates of the drop type, which has been invented by Mr. Charles T. Eaton, East Somerville, Mass. At each landing there are switches, *H*, *H*, and *C*, connected in series in a bell circuit; the groups at the different landings are connected in parallel to the bell main, *B*. The rising and falling gates, *G*, are provided each with a lug, *L*, to engage with a stop, *K*, on the car, *D*, when the car is at a floor and the gate is raised, as shown at the second floor in the diagram. The gate is heavier than its counterweight, *M*, so that when the car leaves the landing and the stop, *K*, releases the gate, the latter

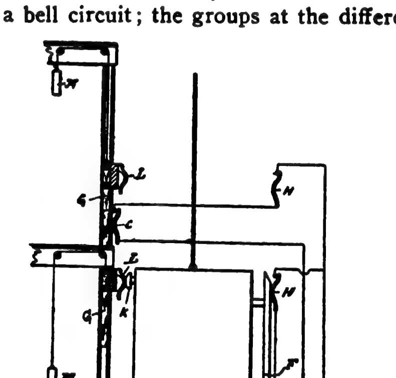

FIG. 2.—SIGNAL FOR ELEVATOR GATES.

drops to its closed position. In that position, it opens the switch, C, on its floor, and prevents the switch, H, on that floor from ringing the alarm bell. Should the gate stick, however, after the car leaves the floor, the switch, C, will remain closed, as shown at the second floor; the switches, H, H, which are held open by the skate, F, while the car is at or near the landing, are released when the car clears the landing, and their closure rings the alarm bell, the circuit being intact through the gate switch, C. It is difficult to see of what utility the system could be in preventing persons from walking through the open gate unless the bell were of such size as to be heard all over the building. The usefulness of the skate, F, is also obscure. Patent No. 777,612.

Wiring Cleat.—The cleat or clamp from an insulator knob for electric wires is familiar to those interested in such matters. Fig. 5 illustrates a new form of this type of knob which has been patented by Mr. E. C. Hunt, of Belle Plaine, Iowa. The insulator comprises a knob and a cap, both grooved on their abutting faces to receive the wire and also provided with a groove in the knob and a corresponding ridge on the cap to serve as a sort of pivot and ficilitate the clamping of the wire when a screw is set through the hole in the center into the material upon which the knob is mounted. The principal feature, however, is the shape of the central hole through the knob portion; the hole is round at the clamping face, but widens progessively into an oblong section at the back end, as shown at I in Fig. 3; the object of this is to allow the screw to be set at an angle, as shown here, whenever that may be necessitated by local conditions. The foce of the knob from the fulcrum ridge, C, to the extreme edge is slanted, as indicated at H,

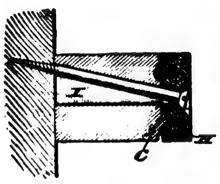

FIG. 3.

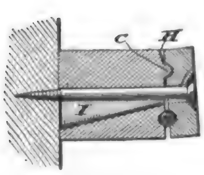

FIG. 4.

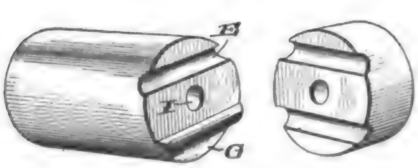

FIG. 5.—WIRING CLEAT.

Fig. 4, in order to give room for the tilting of the cap when a larger wire is clamped in the wire groove. This is shown in Fig. 4, which also shows the retaining screw set in straight, as it would be under ordinary conditions. Patent No. 776,514.

CENTRAL STATION ENG NEERS.

III.

Charles L. Edgar.

Charles L. Edgar was born December 23, 1860, at Griggstown, N. J., a small village on the line of the Delaware and Raritan Canal. His early education was such as the district school at that time afforded, and after reaching adult years he prepared for Rutgers College, which he afterwards entered and from which he graduated with honors in 1882. After graduation he took up post-graduate work in electrical engineering at Rutgers under Professor Francis Cuyler van Dyck, and in January, 1883, applied to the Edison Laboratories at Menlo Park, N. J., for employment. He was sent to the Edison Machine Works on Goerick Street, New York City, where he remained nine months. From here he was transferred to the works of the Bergman Company, manufacturer of central station apparatus, where he remained only a month, entering the service of the Edison Company, where he was employed until 1887 in general engineering work and installing small central stations throughout New York and Pennsylvania. In August, 1887, he was sent by the parent company to Boston as superintendent of the Edison Electric Illuminating Company of that city. Two years later found him general manager and early in the 90's vice-president. He retained the vice-presidency and general managership of the company until 1900, when on the death of Jacob Rogers, he became president of the company, which office he still holds. Mr. Edgar was president of the Association of Edison Illuminating Companies for 1893, 1894 and 1895, and was thrice vice-president of the National Electric Light Association, succeeding to the presidency of the latter organization in 1904. For the past three years he has been president of the Massachusetts Electric Light Association, and he is at the present time chairman of the Boston branch of the American Institute of Electrical Engineers. His ability as a central station manager is evidenced by the wonderful growth of the Edison Company, of Boston, under his management, and it is due to his progressive methods that the company stands to-day as the exponent of all that is modern in central station practice. The introduction of the vertical engine and the storage battery into the equipment of central stations are features with which his name has been actively associated. With a view to thoroughly investigating the subject of vertical engines and storage batteries, Mr. Edgar made two trips to Europe, and as the result of his investigations the vertical engine was adopted by the Edison Company, and storage batteries were first used as a central station adjunct in Boston. In 1898 Mr. Edgar visited England for the purpose of studying the Wright demand system of charging, and on his return the system was adopted by the Boston company, and is still in use there. Mr. Edgar has made several other trips abroad for the purpose of investigating foreign methods, and has given his company the benefit of such features as could be advantageously applied, especially in the line of central station construction. Mr. Edgar is a man of pleasing personality, and one whose influence is felt by all with whom he comes in contact, both socially and commercially, and despite his remarkable success he retains the most democratic characteristics. One of his most remarkable qualifications is his ability to observe and control the most minute details connected with the vast business of which he is the head.

CHARLES L. EDGAR.

NOTES.

An Electrolytic Telephone.—In connection with the Jubilee Exhibition held by the German Electrical Society in Berlin, Mr. E. Ruhmer exhibited a rather curious apparatus in the shape of an electrolytic telephone receiver. This apparatus consists mainly of an electrolytic cell containing electrodes of unequal size. On being traversed by microphone currents, this cell reproduces any words spoken into the microphone to which it is connected.

A New Suggestion for Peat Utilization.—Attempts have been made for a long time to utilize the enormous stores of peat possessed by many European countries. Now a Galician engineer is said to have succeeded in working peat into fuel by the addition of naphtha; tests of the product are said to have shown it to be a perfect equivalent of brown coal. Further tests made at the laboratory of Lemberg University have brought out the fact that common raw

oil or preferably the waste from oil refining may be used in the place of naphtha, thus further reducing the cost of manufacture to a considerable extent. According to calculations made at the peat utilization department of the State Agricultural Experimental Office of Vienna, the heating value of peat worked with oil waste is even higher than in the case of an addition of naphtha. The inventor submitted his products to a commission of experts at Berlin, by whom they were judged favorably. Applications have been made for patents covering the process.

The Interstate Independent Telephone Convention—The fourth annual convention of the Interstate Telephone Association was held at the Auditorium Hotel in Chicago on December 13, 14 and 15. Interesting papers were presented by Theodore Thorward, of South Bend, Ind.; E. D. Graham, of Mexico City, Mo.; Mr. J. H. James, of Mankato, Minn., and Rome C. Stephenson, of Rochester, Ind. The election of officers resulted as follows:

President, Theodore Gary, of Macon, Mo.; vice-president, William R. Fee, Milford, O.; secretary, L. L. C. Brooks, St. Paul, Minn.; treasurer, A. B. Conklin, Aurora, Ill. The executive board recommended consisted of Hon. C. E. Hull, Salem, Ill.; S. S. Lichty, Clinton, Iowa; J. G. Splain, Pittsburg, Pa.; Richard Valentine, Janesville, Wis.; W. Mathews, Maysville, Ky.; E. D. Graham, Mexico, Mo.; Charles W. Wells, Marion, Kan.; H. A. Barnhart, Rochester, Ind.; W. Gray Jones, Columbus, O.

Electric Power Transmission in a Motor Launch.—The use of oil engines jointly with electric motors for the driving of automobiles is now well known, numerous systems of such mixed operation having been developed in recent years. Now an interesting attempt to use a similar combination for the propulsion of motor boats is being made by the Companie de l'Industrie Electrique et Mécanique, of Geneva, Switzerland. The General Navigation Company of the Lake of Geneva is having built a boat intended for freight service on the lake, the power necessary for the propulsion of the boat, as well as for working the capstans, being supplied by a Diesel engine built by the Sulzer firm. The engine runs only in one direction, and at a fixed speed, and special means are provided to secure the starting, acceleration or retardation of speed, and reversing of the propeller. These consist of an electric generator and an exciter dynamo mounted on the shaft of the Diesel engine, an electric motor mounted on the propeller shaft, and an electromagnetic clutch between the ends of the engine shaft and the propeller shaft, the two being in axial alignment, of course. In starting, the engine shaft is unclutched from the propeller shaft and the engine brought up to normal speed in the usual way. Then the generator and motor are excited and the latter brought up to speed by means of a controller, if full propeller speed is desired; the two shafts are then clutched and the generator and motor are "killed" in order to avoid their internal losses; the exciter continues active, as it energizes the clutch. For reverse running, at all speeds, the shafts are unclutched and the propeller driven by the motor. This is also done for forward running at speeds below the maximum.

The National Electric Light Convention—The electrical fraternity throughout the entire Middle West has united to entertain delegates to the convention to be held by the National Electric Light Association in June. The convention will be held in Denver, but all of Colorado's neighboring states are interested in making it a success, and in giving the delegates the best entertainment ever provided for any convention. Two preliminary committee meetings have been held. At the first the central station men decided, with President Ernest H. Davis, that the business sessions should be held in Denver. Colorado Springs was such a close competitor for the meeting that it was decided to take the whole convention to that city for two or three days of entertainment, and those present from other cities said that they intended to entertain parties of delegates, so that arrangements can be made by delegates to visit any particular section, with the assurance that they will be cared for properly. After the first preliminary meeting Mr. Davis appointed Mr. Henry L. Doherty, president of the Denver Gas & Electric Company, as the representative of the National Association in the West, to take charge of the arrangements for the convention, and Mr. Doherty has secured the co-operation of the central station men, the business men and the railroad men in this work. The hotel men say that every effort will be made to care for the delegates properly, and that rates will not be increased in any way. The railroad men say that low rates can be assured for the meeting; one fare for the round-trip from Chicago, St. Louis and points in that vicinity, and for that portion of the trip east of these points, a round-trip fare of one and one-third times the single fare. It may be possible to obtain even lower rates, though the schedule assured means a good time limit.

Evening Courses in Electrical Engineering.—The Polytechnic Institute of Brooklyn (N. Y.) has inaugurated a series of evening lectures in electrical engineering, the first lecture having been delivered on December 15. The course covers four lectures on Commercial Engineering, by Mr. Charles F. Scott, consulting engineer of the Westinghouse Electric & Manufacturing Company; eight lectures on Central Station Practice, by Mr. W. S. Barstow, the well-known consulting engineer; eight on Electrical Power Transmission, by Dr. F. A. C. Perrine; eight on Electric Traction, by Dr. Louis Duncan, and eight on Telephony, Telegraphy and Patent Practice, by Mr. Thomas D. Lockwood, of the American Bell Telephone Company.

Mr. Barstow delivered his first two lectures on December 15 and 21, and Mr. Scott delivered his first one on December 21; the remaining lectures by these two gentlemen are to be as follows: Mr. Barstow, January 5, 17 and 31, February 14 and 28, and March 14; Mr. Scott, January 25, February 16 and March 16. The subject of Mr. Barstow's first lecture was "Local Conditions Governing the Selection of the System." The speaker took up in detail the preliminary determinations which a consulting engineer should make before recommending and laying out a central station for lighting and power work, such as determining the character of the community, its past and probable future growth, franchise conditions, the location of the station with reference to fuel and water supply, cost of labor, etc. The lecture was extremely interesting, since it was really devoted to a practical consideration of some of the problems which the consulting engineer must meet in every-day work. Pamphlets containing the full lists and all information concerning the lectures may be had on application to Dr. F. W. Atkinson, president of the Institute.

Some Difficulties in Getting On is the title of an extremely interesting address delivered recently to the students of the Institution of Electrical Engineers, of Great Britain, by Mr. James Swinburne, past president of the Institution. Mr. Swinburne pointed out two vital facts relating to technical education—one, that teachers of science seem to think that the practical application of their science is degrading and business ability is to be despised; the other, that the natural tendency of educational institutions is toward the unpractical, for the reason that graduates of such institutions who have good practical judgment in the application of their learning go out into the world and apply it, while the teachers of the succeeding generation are men devoid of the characteristics which make successful business men, engineers, etc. As to the pursuit of knowledge, says Mr. Swinburne, "No knowledge is worth obtaining for its own or any other sake unless it is or probably will be useful to man." Concerning engineering work, Mr. Swinburne commends an "American definition of an engineer," which he says is "a man who can do for one dollar what any fool can do for two." This, he says, "is not poetical, and it is useless for oratorical purposes, but it is right." Scientific training and knowledge are priceless, he says, but "every design, every engineering manufacture, every piece of engineering is only a question of price. It is unpleasant, perhaps, but it is a hard fact, and we have got to face it. If one of us earns £100 a year and does £150 worth of work, he is efficient, but if he only does £90 worth he is inefficient, and will come to grief." As to hard work: "A hard struggle is a very good thing for a young man who has anything in him. It gets him into the way of overcoming difficulties, so that when he gets above the small obstacles he goes on overcoming large ones from mere force of habit."

We regret very much that space limitations prevent the publication of the entire address; it is well worth study by budding engineers.

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CONTENTS.

The New Year.

It gives us much pleasure to greet our readers and other friends on this the ninth New Year's Day since *Electrical Industries* became the AMERICAN ELECTRICIAN. We print elsewhere in this number letters, from business establishments distributed throughout the country, concerning the business conditions during and at the close of 1904. The opinions expressed have not been modified in the slightest degree by the editorial blue-pencil, nor have any communications been omitted. In view of these facts, the letters published may be considered to reflect the general sentiment throughout the electrical and allied trades, and judging by the great preponderance of optimistic opinions among the writers, 1905 should be a great improvement over the year just closed, if it does not inaugurate an era of prosperity similar to that enjoyed a few years ago. However this may be, we sincerely wish for the electrical fraternity a bountiful measure of success and a continuance of the progress which has carried American electrical industries to the front of the international ranks.

Difficulties in "Getting On"

On a preceding page we print a few excerpts from an address recently delivered by Mr. James Swinburne to a body of English students. This address contained much valuable advice, and we regret the impracticability of reprinting it in full. Among the hints delivered by the author, we note a strong recommendation to specialize, but not too narrowly. This may be difficult, and it is frequently the case, says Mr. Swinburne, that a man is buffeted about and prevented from taking up immediately the special work for which he is best equipped, or which he prefers. As we have pointed out in these columns before, it is better to know one thing perfectly, without much other knowledge, than to have a superficial smattering of several or many things without a "working" knowledge of any. What one's specialty is to be is too often determined by chance, but it is not wholly impossible to work into the right direction by dint of hard struggling and perseverance; success worth having is never attained without plenty of hard work and discouragement. On this point Mr. Swinburne said: "Nearly all great men rise from almost nothing with infinite trouble in their youth. There is nothing worse for a young man than to have about $1000 a year of his own; if any of you has this sort of private income he had better go into partnership in installation work for a year or two, and then begin his business seriously." This advice is excellent in the main, although we do not quite follow the intimation that installation work is not serious business—it certainly is in this country.

Mr. Swinburne gave educational institutions a hard knock, and while conceding the value of the learning obtained from those institutions, dwelt with undue force on the unpractical nature of their faculties. It is, of course, true that college professors are not practical engineers, as a rule, their ranks being ordinarily filled by men who have either no taste or no ability for actual engineering work. But there are notable exceptions to the rule, and we scarcely think Mr. Swinburne's argument that each generation of pedagogues is more unpractical than the preceding one is tenable, unless the conditions in this respect are vastly worse in Great Britain than here. If a college professor can be an engineer, or a physician, or a lawyer, as the case may be, so much the better for his students; but even without any of the qualities that would make for success in the application of his learning, if he has the ability to impart his knowledge to his classes, the benefit to those classes is priceless.

The High Voltage Incandescent Lamp.

The development of the 220-volt incandescent lamp has not effected the changes in central station practice in this country that were generally expected when its advent was first announced. Most stations of medium and small size continue to use 110-volt to 120-volt lamps, employing three-wire distribution when distance makes two-wire circuits impractical, and all of the large stations of which we have knowledge, excepting the one in San Francisco, use the three-wire system for all direct-current incandescent lighting. The prime reason for the continuance of the 110-220-volt, three-wire distribution by the big stations is obvious; their underground mains are all laid that way and the cost of changing over would be prohibitive, even if the high-voltage lamp justified it otherwise. In smaller stations, however, the reason for not changing over is not so immediately apparent. The high-efficiency 220-volt 16-c.p. lamp takes only 60 watts, as compared with 50 watts for the same class of 110-volt lamp, and it would seem that the saving in copper and balancing apparatus would compensate for the difference in the economies of the two lamps. In actual practice, how-

ever, we doubt that this would be true in any considerable percentage of cases.

A rough idea may be obtained by considering the chief differences between a plant having a 500-kw. lighting load peak, using 110-volt lamps on a three-wire distribution system, and a plant of the same lamp load using 220-volt two-wire distribution. Assuming in both cases that the peak covers two hours, that the average load during the remainder of the 24 hours is 16 per cent. of the peak load, and that 85 per cent. of the lighting load is in incandescent lamps—which assumptions are as favorable to the high-voltage lamp as one could reasonably expect—we get the following approximate data. The incandescent part of the peak load will be 425 kilowatts or 8500 lamps; the average during 22 hours of each day will be 85 kilowatts, or 1700 lamps; the generating plant must have a maximum capacity of 500 kilowatts and balancing apparatus of about 50 kilowatts capacity will be required. If the distribution mains contain $17,000 worth of copper devoted to the lamps alone, about $4000 of this will be in the neutral conductors. The generating plant, steam and electrical, at $110 per kilowatt will cost $55,000, and the balancing apparatus, involving no steam apparatus, will cost about $1000 installed. At a cost of 2 cents per kilowatt-hour for energy at the switchboard during the peak and 4 cents during the remainder of the 24 hours, the current operating cost will be $85 per day of 24 hours. The interest and depreciation on the balancing apparatus and neutral conductors will be at least $400 per annum—say, $1.10 per day; that on the remainder of the station apparatus will be about $6000 per annum—say, $16.40 per day. The items mentioned will foot up $102.50 per day.

On the foregoing basis, the two-wire 220-volt plant will have a peak load of 585 kilowatts, and an average load for 22 hours of 97.5 kilowatts, owing to the difference in lamp efficiency, and the operating cost will be $109.20 per day. The interest and depreciation on the generating plant will be about $6500 per annum, or $1.75 per day, making the total charges under consideration $110.95 per day as compared with $102.50 in the other case. These, of course, are not all of the factors to be considered; they are the principal ones, however, and this rough comparison indicates that conditions would have to be extremely favorable to the high-voltage lamp in order to justify its use to the exclusion of the lower-voltage lamp. If the cost of the copper in the neutral conductors were very much higher per lamp of load, if the cost of the balancing apparatus were greatly above that assumed above, relatively, and if the operating cost were lower, then there might be a better prospect for the 220-volt lamp.

There is no doubt that many three-wire plants find the 220-volt lamp very convenient for use in outlying and scattered districts where the load is not large and the cost of the neutral conductors would be disproportionate. This class of load does not constitute a sufficiently large percentage of the total station load to affect the cost of current supply appreciably. We are more and more firmly convinced, however, that the solution of the problem of low-potential distribution lies, not in the abolition of the three-wire system nor in jumping from 110 or 115 volts at the lamps to twice that e.m.f., but in raising the wire-to-wire voltage to the point where the over-all voltage of a three-wire system will be the limit allowed by the Underwriters, namely, 300 volts; 150-volt lamps are more practical than 220-volt lamps, and the former voltage is much more manageable in small devices, such as lamp sockets, receptacles, etc.

Electricity in the Drafting Room.

Even in industrial establishments and engineering offices where special efforts are made to increase the efficiency of the drafting force, it is doubtful that the full convenience of applied electricity is always realized. It is not uncommon to find in such places lighting arrangements which are not favorable to the most ordinary work, and which make it impossible to turn out, with any degree of comfort and speed, work of especial accuracy. Again, the chief draftsman's desk is not always provided with a telephone in establishments having an intercommunicating or private branch exchange switchboard system, and valuable time is wasted in going to and from the telephone. Many other apparently unimportant but really serious short-comings can be picked out in most drafting departments if one but takes the time and trouble to analyze the conditions carefully.

While very good general illumination has been secured by means of inverted arc lamps and white ceilings and walls, it is doubtful if anything is more satisfactory than individual incandescent or Nernst lamps intelligently disposed. Ceiling or wall clusters are of no use whatever beyond general illumination, enabling one to walk through the room without collision with a table or chair and to locate drawing cases, etc. For the actual inspection of drawings or prints in their files, a hand lamp on a flexible cord is much superior to any kind of fixture, and will usually make it possible to look over drawings without removing them from the cases. Another great convenience is a "bung-hole" lamp mounted beneath a glass drawing board to facilitate tracing a faint or weather-beaten original or other drawing.

Electric blue-printing apparatus is deservedly coming into wide use in drafting rooms where the output is large. The advantages of this class of apparatus are conspicuous. They render one independent of fickle weather conditions, and eliminate the pent-house, which usually exposes valuable tracings to the dangers of tearing and soiling on windy days and serious damage when rain comes up suddenly. Several hundred blue-prints per day can be run off on a machine of the type mentioned, and all with a degree of certainty and cleanliness which the ordinary sunlight method cannot approach. For drying and smoothing blue-prints, an electric flatiron is excellent, but it should not be applied directly to the print, of course.

Still another convenience, in establishments where photographing is done in the drafting department, is an electrically-lighted dark room, the lamp being an ordinary one mounted outside a ruby or orange-colored window in the wall of the dark room; whenever the natural light available through the window from the drafting room is sufficient, the special dark room lamp, of course, need not be lighted. For drying newly-developed plates, a small fan-motor is extremely useful, and will usually save from 85 per cent. to 90 per cent. of the time required for drying in still air.

Last, but far from least, efficient ventilation of a drafting room is best secured by means of motor-driven fans—not the ordinary fan-motor of the "buzz" propeller type, but fans built especially for ventilating purposes and intelligently installed. Drafting is arduous work, and good ventilation is as important to the efficiency of the men engaged in it as any other factor, excepting good illumination. Other improvements by means of electrical facilities will readily suggest themselves to any chief draftsman who chooses to consider the question seriously and in detail.

DESIGN AND CONSTRUCTION OF SMALL DYNAMOS AND MOTORS.

BY CECIL P. POOLE.

After completing the "laying-out" of the armature and its winding, the commutator and brushes, the amateur builder may pass on to the field magnet and winding. Tables VIII and IX gave the dimensions which

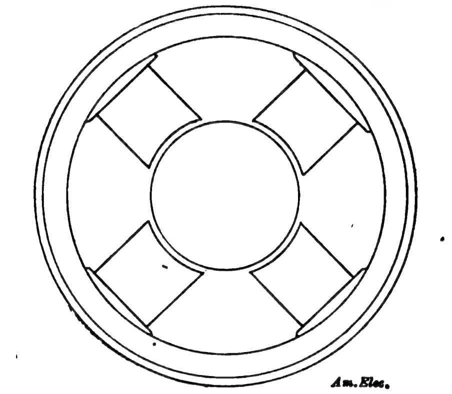


FIG. 7.

affect the electrical and magnetic features of the machine. The complete field magnet should be worked out before taking up the winding. Fig. 7 represents the familiar "circular-yoke" type of frame which is so much used now. On account of its conventional character, the builder may prefer to

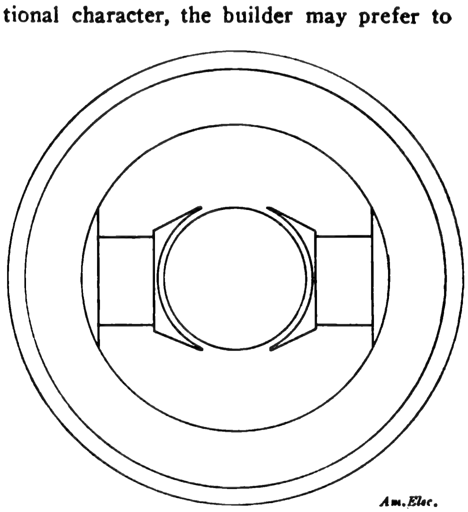


FIG. 7-A.

use it, but the writer prefers the less graceful shape shown by Fig. 8 for machines smaller than 8 inches polar bore. Figs. 7-A and 8-A show the bipolar frames corresponding respectively to the four-pole frames of Figs. 7 and 8. It is not intended that the shapes of magnet core shown shall be considered as belonging to these forms of

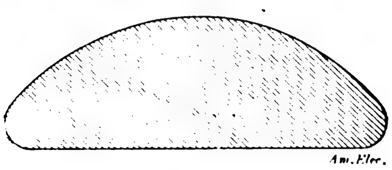


FIG. 9.

frame; they are only conventional, being shown merely to indicate the number of poles. If the circular yoke is used, then "pads" must be cast on the inside of the yoke to give flat surfaces for the seating of the magnet cores in those machines having cast-iron yokes and steel magnet cores, or to back up the coils of machines having the yoke and cores cast in one piece of iron or steel. These are shown in Figs. 7 and 7-a.

The width of the yoke parallel to the shaft should, if practicable, be sufficient to cover the magnet coils completely; if cast-iron is used, this can be done in all cases, but if the yoke of a multipolar machine is of cast steel, it will usually be too thin in

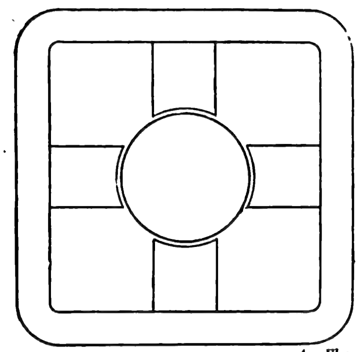


FIG. 8.

the direction at right angles to the shaft if it is made wide enough to cover the magnet coils. For cast-steel yokes, therefore, it is advisable to follow the rule of making the yoke thickness not less than ⅛ the axial width for circular yokes or ⅙ the axial width for other shapes. This will be accomplished by observing Rule XV. The yoke cross-section must be slightly thinner at the edges than in the center in order to facilitate casting it, and the machine will have a much better appearance if the dif-

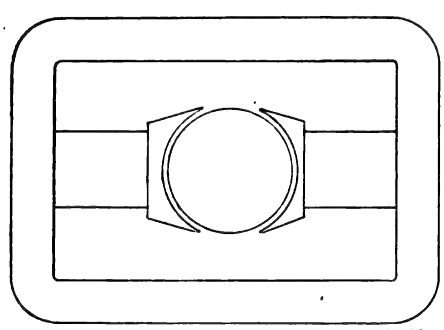


FIG. 8-A.

ference is something like 1½ or 2½ to 1; that is, if the yoke is 1½ or 2½ times as thick in the center as it is at the edges, as indicated by Figs. 9 and 10.

Fig. 9 represents the preferable shape of yoke cross-section to be used on a machine of the "box" type and also in circular machines having the journal boxes mounted

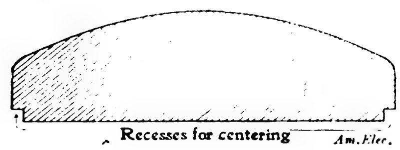


FIG. 10.

in vertical pedestals seated on projecting feet at the bottom of the frame, or on a base, as in Fig. 11. For machines having circular journal brackets, as in Fig. 12, the edges of the yoke must be thick enough to give a good bearing to the journal bracket ring and to take the bolts holding the ring in place; in such cases, the edges of the yoke ring must be machined flat, of course, and it will be found advantageous to tool out a slight recess, for centering the bracket ring, as indicated in Fig. 10. This will affect the relation between the yoke thickness at the edges and that at the center somewhat, but it will always be found practicable to "swell" the cross-section from the edges toward the center to some extent. The thickness mentioned in Rule XV is the *average* thickness, or one-half the sum of the edge and center thicknesses.

As the depth of the armature coil slots,

FIG. 11.

and therefore the length of the core teeth, cannot be fixed for each diameter of armature, it is impracticable to prescribe the field windings for the different diameters. The only way by which the builder can avoid the labor of calculating the field winding, which would be a tedious process neces-

TABLE X.—Size of Wire for Test Field Winding.

Length, inches.	Depth of coil, inner to outer layers inclusive; inches.						
	1	1¼	1½	1¾	2	2¼	2½
1	22	21	20	19	19	18	17
1¼	21	20	19	18	17	17	16
1½	20	19	18	17	17	16	16
1¾	19	18	17	17	16	15	15
2	19	17	17	16	15	15	14
2¼	18	17	16	15	15	14	14
2½	17	16	16	15	14	14	13
2¾	17	16	15	15	14	13	13
3	17	16	15	14	13	13	12
3¼	16	15	14	14	13	13	12
3½	16	15	14	14	13	12	12

The above numbers are wire sizes, B. & S. gauge.

sitating a knowledge of the most difficult part of dynamo designing, is to wind test coils for his machine and vary the field excitation until the desired e.m.f. of a dynamo, or speed of a motor, is obtained; then determine the permanent winding from the data derived from this test. Table X gives the proper size of wire to be used in

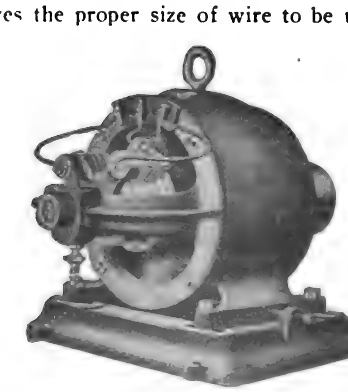


FIG. 12.

the test coils for different thicknesses and lengths of coil; the test coils should be wound to fill exactly the space that will be occupied by the permanent coils. Rule XVI gives appropriate proportions for field

magnet-coils. The determination of the size of wire for the permanent winding is as follows:

Connect the test winding to a 110-volt or 125-volt circuit in series with a small water rheostat, through a double-pole knife switch, with the rheostat adjusted to its highest resistance; drive the armature by belt at its rated speed if a dynamo; if a motor, drive it at 1.05 times its rated speed. Connect one terminal of a voltmeter to one of the terminals of the test winding and one of the commutator brushes of the machine; connect the other voltmeter terminal to a double-throw switch so that it can be connected to either the other terminal of the test winding or the other commutator brush, as indicated by Fig. 13. Start the test with the voltmeter connected to the brushes and proceed as follows:

Shunt-wound Dynamo.—Reduce the resistance of the water rheostat until the armature gives its full rated voltage with full load on it and running at rated speed. Switch the voltmeter over to the test winding and take the voltage at its terminals. Find in Table XI the column at the head of which is the size of wire that is in the test winding; trace down this column until the nearest larger number to the number of volts at the test winding is found; trace to the right along this line to the number in the column headed by the voltage of the machine; this last number will be the size of wire to be used in the permanent field winding.

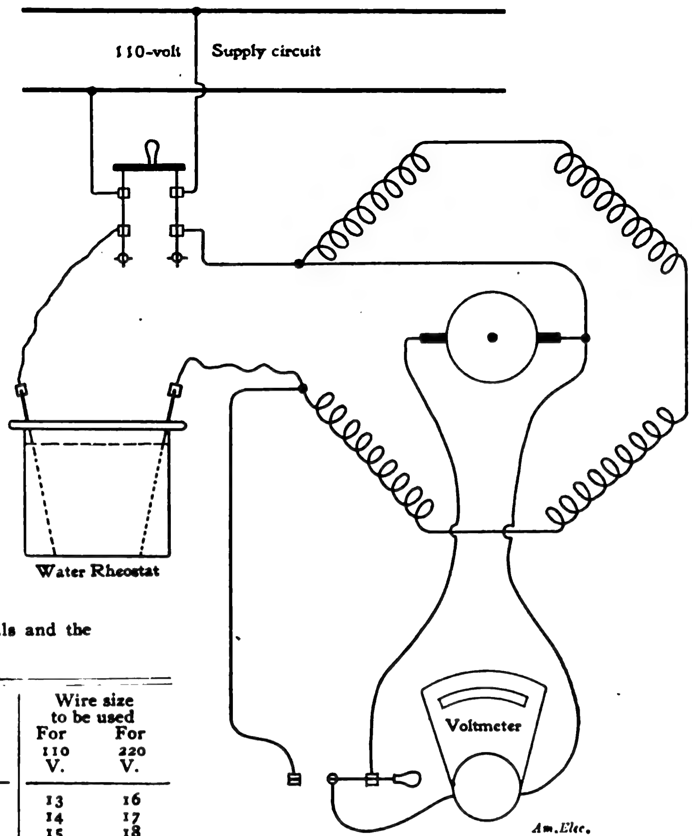


FIG. 13.

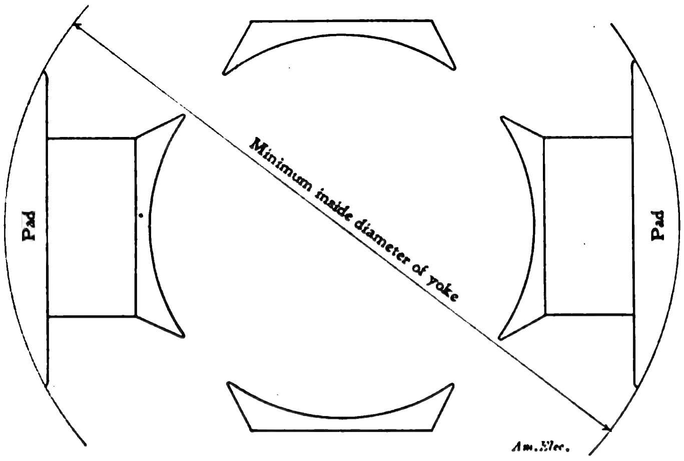


FIG. 14.

Rules.

Rule XV.—To ascertain the minimum thickness for a steel field magnet yoke, divide the cross-sectional area (Table IX) by 6, for a box yoke, or by 8, for a circular yoke, and take the square root of the result. If this does not give a practical working dimension, take the nearest larger practical dimension.

Rule XVI.—The thickness of each field magnet coil of a shunt-wound machine must be equal to not less than one-half of its length along the core and not more than the whole length.

The length of each field magnet shunt coil of a compound-wound dynamo must be equal to not less than 2/3 nor more than 3/4 of the total coil space along the magnet core.

The thickness of each field magnet coil of a compound-wound dynamo should be equal to 2/3 of the total coil space along the core.

TABLE XI.—Relation between size of wire in test field magnet coils and the size to be used in the permanent magnet coils.
For 110 and 220-volt machines.

Size of wire in test winding, B. & S. gauge. 12	13	14	15	16	17	18	19	20	21	22	Wire size to be used For 110 V.	For 220 V.
86.9	110.	....	....	....	....	....	....	....	....	....	13	16
68.7	86.9	110.	....	....	....	....	....	....	....	....	14	17
54.5	68.9	87.25	110.	....	....	....	....	....	....	....	15	18
43.5	55.2	69.85	88.	110.	....	....	....	....	....	....	16	19
33.9	43.	54.4	68.55	85.65	110.	....	....	....	....	....	17	20
26.8	34.	42.95	54.15	67.65	86.9	110.	....	....	....	....	18	21
21.7	27.5	34.8	43.9	54.8	70.4	89.1	110.	....	....	....	19	22
17.2	21.7	27.5	34.65	43.3	55.6	70.4	86.9	110.	....	....	20	23
13.6	17.2	21.8	27.5	34.35	44.1	55.85	68.95	87.25	110.	....	21	24
10.7	13.6	17.2	21.65	27.05	34.75	44.	54.3	68.75	86.7	110.	22	25
....	10.8	13.7	17.3	21.6	27.75	35.1	43.35	54.85	69.2	87.8	23	26
....	....	10.85	13.7	17.1	21.95	27.95	34.3	43.4	54.7	69.4	24	27
....	....	....	10.85	13.55	17.4	22.	27.2	34.4	43.4	55.05	25	28
....	....	....	....	10.7	13.75	17.35	21.45	27.15	34.25	43.45	26	29
The numbers in this section of the table are volts at the terminals of the entire test winding.					10.95	13.85	17.1	21.65	27.3	34.65	27	30
					....	10.9	13.5	17.05	21.5	27.3	28	31
					....	....	10.85	13.7	17.3	21.95	29	32
....	....	....	....	....	....	....	....	10.75	13.55	17.2	30	33
....	....	....	....	....	....	....	....	....	10.7	13.6	31	34
....	....	....	....	....	....	....	....	....	....	11.	32	35

TABLE XI (Continued).—Relation between size of wire in test field magnet coils and the size to be used in the permanent magnet coils.
For 250 and 500-volt machines.

Size of wire in test winding, B. & S. gauge. 12	13	14	15	16	17	18	19	20	21	22	Wire size to be used For 250 V.	For 500 V.
98.75	125.	....	....	....	....	....	....	....	....	....	16	19
78.	98.75	125.	....	....	....	....	....	....	....	....	17	20
61.9	78.35	99.15	125.	....	....	....	....	....	....	....	18	21
48.75	61.75	78.15	98.5	123.	....	....	....	....	....	....	19	22
38.9	49.25	62.35	78.6	98.2	123.	....	....	....	....	....	20	23
30.8	38.95	49.3	62.2	77.65	99.75	....	....	....	....	....	21	24
24.4	30.9	39.1	49.3	61.6	79.1	100.1	123.6	....	....	....	22	25
19.25	24.4	30.85	38.9	48.6	62.4	79.	97.5	....	....	....	23	26
15.35	19.4	24.6	31.	38.75	49.75	63.	77.8	98.4	124.	....	24	27
12.2	15.3	19.4	24.45	30.5	39.2	49.6	61.3	77.5	97.95	124.	25	28
....	12.3	15.6	19.65	24.55	31.5	39.9	49.25	62.35	78.6	99.75	26	29
....	....	12.2	15.4	19.2	24.7	31.25	38.55	48.8	61.55	78.1	27	30
....	....	....	12.2	15.2	19.55	24.75	30.55	38.65	48.75	61.85	28	31
....	....	....	....	12.3	15.8	20.	24.7	31.25	39.4	50.	29	32
The numbers in this section of the table are volts at the terminals of the entire test winding.					12.25	15.4	19.4	24.5	30.9	39.	30	33
					....	12.25	15.4	19.45	24.5	31.	31	34
					....	....	12.2	15.4	19.45	24.55	32	35
....	....	....	....	....	....	....	....	12.2	15.4	19.5	33	36
....	....	....	....	....	....	....	....	....	12.2	15.45	34	37
....	....	....	....	....	....	....	....	....	....	12.25	35	38

Compound-wound Dynamo.—Proceed as before, except that the armature must be run without any load.

Shunt-wound Motor.—Proceed as before, except that the armature must be driven (by belt as a dynamo) at 1.05 times its rated speed and without any load.

If a direct-reading speed-indicator is available, the motor test may be made by running the armature free, as a motor, from a circuit of the proper voltage, adjusting the water rheostat until it runs at the proper speed and then taking the voltage at the terminals of the test winding. This, however, is much more difficult to carry out accurately than the dynamo test.

TABLE XII.—Field Magnet Series Windings.
The current specified in the table is the maximum that is allowable in series magnet coils.

Wire size.	Am. peres.	Wire size.	Am. peres.
No.		No.	
4	28	10	6
5	22	11	5
6	17	12	4
7	13	13	3
8	11	14	2½
9	8½	15	2

The size of wire to be used in the series winding of a compound-wound machine may be obtained from Table XII. These sizes are empirical and it may be found necessary to use a "shunt strip" across the terminals of the series winding after the machine is finished. This can be easily determined by running the machine without load and with the field rheostat adjusted to obtain the proper voltage at the brushes, and then putting on full load without changing the rheostat and maintaining the speed constant. If the voltage at the brushes is excessive at full load, the series winding must be shunted until the proper voltage is obtained. If it is too low, the speed of the machine must be increased until the desired voltages are obtained at no load and full load, and this speed must be taken as the running speed of the machine. At each change of speed, the field rheostat must be adjusted to get the proper no-load voltage and left unchanged for the corresponding full-load trial.

The following example will serve to make the application of the rules and instructions in the present article clearer: Suppose a 4-pole machine has been built of the circular yoke type with a 10-inch polar bore and magnet cores of circular cross-section. From Table IX, the necessary cross-section for each magnet core (of steel) is 15¾ square inches, and from any table of circle diameters and areas it will be found that the core must be 4½ inches in diameter to have the required cross-section. The length of the coil space along the core must be 2⅛ inches. The machine is to be a compound-wound dynamo, to give 110 volts at no load and 120 volts at full load. From Rule XVI, the coils should be ⅔ of 2⅛, or about 1 7/16 inches, thick; it is not necessary to split hairs here, so the thickness may as well be made 1½ inches. The outside diameter of each coil, therefore, will be a trifle over 7½ inches (core diameter 4.5 + slight clearance + twice coil thickness) and the "pad" on the inside of the yoke ring must be at least that large, say 7¾ inches in diameter. By laying out the armature circle and magnet cores as indicated in Fig. 14, the inside diameter of the yoke ring is immediately obtained.

The yoke, if of cast iron, must have 21 square inches of cross-section. In order to cover the magnet coil satisfactorily it must be 8 inches wide, at least; the average thickness must then be $21 \div 8 = 2⅝$ inches, and this will be obtained if the edges be made 2 inches and the center 3¼ inches thick, or 1¾ and 3½ inches respectively. If a steel yoke is to be used, the cross-sectional area must be 0.4×21, or 8.4 square inches. From Rule XV, the average thickness must be at least

$$\sqrt{⅛ \textit{ of cross-section}},$$

which is 1.025 inches; if the edges be made ¾-inch thick and the center 1⅜ inches, the average will be 1 1/16 inches and the necessary width $8.4 \div 1.0625 = 7.905$ inches; 8 inches, of course, would be taken for the width.

If the rated speed is, for example, 1000 r.p.m., the machine should be belt-driven at that speed for the excitation test. The shunt coils will be 1½ inches thick and 1½ inches long, and the test coils should have these dimensions; from Table X, No. 18 wire should be used in the test coils. Suppose that at no load the voltage required at the terminals of the test field winding to produce 110 volts at the brushes is 81 volts. In Table XI, for 110-220-volt machines, in the column headed by No. 18 is found 70.4 and 89.1, between which the test voltage lies; take the larger value, 89.1, and trace to the right along that line until the number in the 110-volt column is reached; this is 19, which is the size of wire to be used in the permanent winding. (Just here, the writer would advise that when the permanent wire size comes so near to the test wire size the builder may as well retain the test coils instead of making new ones. The test coils should be well insulated in the winding, with this in view. If they are of wire one size too large the rheostat will need to be of higher resistance than normal, to reduce the shunt current sufficiently; if they are of wire one size too small, increase the speed of the machine to get the desired results.)

The use of Table XII requires no explanation; correction for faulty compounding may, however. Suppose that the machine, complete with its shunt and series windings, gives 110 volts at no load and 112 at full load. Take off the load, set the field rheostat *back* two or three segments (in the direction to decrease the voltage) and speed the machine up until it gives 110 volts without load. Then put on full load and measure the voltage; if it is still under 120, repeat the correction; if it is above, set the rheostat *forward* one segment and reduce the speed until 110 volts at no load is obtained and try the full-load voltage. By successive trials a point can be reached at which proper compounding is obtained. If the machine over compounds at the speed for which it was designed, the speed should not be changed, but the series winding shunted to give the desired results.

PUMPS IN CENTRAL STATIONS.

BY W. T. EDWARDS.

The delivery pipe of pumps may be smaller than the suction pipe; in fact, it need not be more than one-half the area, the velocity of the water being about 400 feet per minute. A check valve should be placed in the delivery pipe and connected directly to the delivery flange of the pump if practical. It should always be straight away, and fitted with hinged or swinging valves. The diameter should always be equal to that of the delivery opening of the pumps.

The loss due to elbows and valves is not a fixed value, and varies according to the conditions of the fittings and the velocity of the water. An approximate rule is to consider the loss in each elbow equal to the loss in a straight pipe, whose length is 60 times the diameter of the elbow, and the loss due to a globe valve equal to the loss in a straight pipe having a length equal to 90 diameters. It is better that all valves used throughout a system should be of the gate type. As the friction of water flowing through pipes, passages, etc., increases as the square of the velocity, it is advisable to keep the velocity as low as possible without making the pipes or pump unreasonably large for a given capacity.

A pump should discharge in a smooth, continuous stream, and in order to secure this, air chambers are placed on the highest point of the delivery chambers. The function performed by the air chamber is that of a cushion to relieve the pump and piping system of shocks or jars due to the intermittent discharge of the pump.

Duplex pumps have a more uniform flow than single-acting pumps, and consequently require a much smaller air chamber; the largest size being used for the single-acting and the smallest size for double-acting duplex pumps.

The vacuum chamber is usually placed so as to receive the full impact of the water in the suction pipe. Its purpose is about the reverse of the air chamber inasmuch as it changes a continuous flow into an intermittent one. Water passing into a pump under atmospheric pressure does so in a continuous stream, and the movement of the pistons causes this water to be received into the pump cylinder intermittently. This interrupted column of water would result in water hammer and other disturbing influences on the pump were it not for the air in the vacuum chamber, which forms an elastic cushion, which receives the excess of flow without noise and gives it out as silently as it receives it. It is not a vacuum chamber, but an air chamber, for there is no such thing as a vacuum chamber connected with a pump.

In all cases where a pump has to take its supply by suction it will be found convenient to provide a priming pipe and a relief pipe both fitted with suitable valves. The priming pipe may be connected to the pump cylinders or to the suction chamber of the pump if there be a foot valve provided in the suction pipe. The priming

pipe may get its supply from a tank, or it may be tapped into the discharge pipe from the pressure side of the check valve. By opening the valve in the priming pipe, water from the tank or reservoir is allowed to fill the pump and suction pipe, while the valve in the relief pipe is opened to allow the air to escape. The relief pipe should be lead to a drain or to any place where it will not cause inconvenience. Centrifugal pumps are sometimes primed by a small hand pump located on the side of the shell, an air cock at the top being opened and the hand pump used until water flows from the air cock. A steam ejector is sometimes used for the same purpose, the passage of the steam forcing the air out of the pump and suction pipe on the same principle that the steam in an injector lifts water and forces it into a boiler. While the priming is being done it is usual to shut off the delivery pipe by closing a gate valve, opening this gradually as the pump comes up to speed. A temporary expedient is to blank off the discharge pipe with a piece of plank held tight against it.

If it is practicable, a pump should be placed on its foundation so that it will be at a convenient height for a man to work around it without stooping. A drip pan should be placed upon the foundation under the pump between the supports or bearings. These pans should be loose, so that they can be removed for emptying. It is a mistake to fasten them to the foundation even though they be provided with a faucet or cock for draining, as the pans will rarely drain clear of themselves, and consequently the water has to be mopped out.

As to which is more economical, the power-driven pump or the direct-acting steam pump, much is said on both sides.

The statement is frequently made without qualification that power-driven pumps are more economical than steam pumps. This may be true under certain conditions, while under other conditions the reverse is the case. With a non-condensing engine where all the exhaust steam is passed through a primary feed-water heater and wasted, other conditions being equal, the power pump is the most economical; but when engines are operated condensing and the exhaust from the pumps is used for heating the feed-water, the steam pump shows up well for economy. However, it is not within the province of this article to enter upon a discussion of the relative efficiencies of the two methods of driving pumps. Under the present approved practice of operating engines condensing, the use of the direct-acting steam-driven pump, utilizing the heat in the exhaust steam for heating the boiler feed-water, is along the lines of best economy. An objection to the use of power pumps is their lack of flexibility. They usually run at a uniform speed, and any excess of water must be wasted through a relief valve, or the boiler filled and the pump stopped until the lowering of the water in the boiler makes it necessary that the pump be started again.

MOTOR-BALANCERS FOR THREE-WIRE SYSTEMS.

BY FRANCIS W. APPLETON.

In stations where it is impracticable to get along with only one pair of dynamos, one on each side of the neutral, it has been invariably found advantageous to use main generators giving the full voltage required between the outside wires of the system and to employ auxiliary means for "balancing" the system, or more correctly, for maintaining the proper voltage on both sides of the neutral despite unsymmetrical variations of the load. One of the simplest means for this latter purpose is the motor-balancer, consisting merely of two dynamo-electric machines exactly alike, each wound for the voltage between the neutral and the outer wires, and having their shafts rigidly coupled. These machines are connected to the distribution circuits as indicated by Fig. 1, and the neutral feeder is not connected to the main dynamo at all.

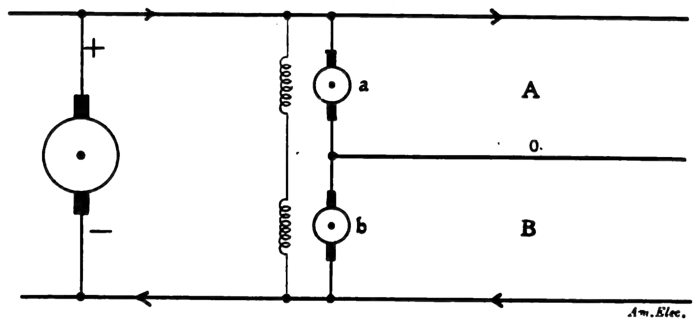


FIG. 1.

So long as the load is balanced, that is, equal on both sides of the neutral feeder, the two machines run as motors. Now, if part of the load on the "A" side of the neutral be thrown off, there will flow in the neutral feeder a current equal to the difference between the currents required by the loads on each side of it; the voltage between the neutral and the positive feeder will be momentarily higher than that between the neutral and the negative feeder because of the difference between the drop in the two outer feeders. Consequently the armature *a* will increase its speed, carrying with it the armature *b*, the counter e.m.f. of which now exceeds the voltage of its half of the system and therefore raises the voltage of that half to a value nearer that of the other side. The current in the neutral feeder will divide almost equally between the armatures *a* and *b*. If the balancer armatures could have no resistance whatever and required no power to drive them, the division would be absolutely equal. This ideal condition is indicated diagrammatically in Fig. 2, where it is assumed that the load in the "A" side is 90 amperes and that in the "B" side 100 amperes. Ignoring losses in the balancer, the motor half, *a*, will require as many amperes to drive the dynamo half, *b*, as that armature delivers to the line, the voltages of the two (assuming temporarily no losses) being equal after the division of the neutral current between them. Therefore, 5 amperes of the 95 supplied by the main generator passes through the armature *a* to the neutral wire, enabling that armature to drive the armature *b* at such a speed that its excess in voltage over the line voltage causes it to supply 5 more amperes, which join the 5 amperes of motor current at the neutral junction, making 10 amperes in the neutral feeder. The motor-balancer, therefore, only needs to have a current-carrying capacity equal to one-half of the current in the neutral feeder under the worst load conditions.

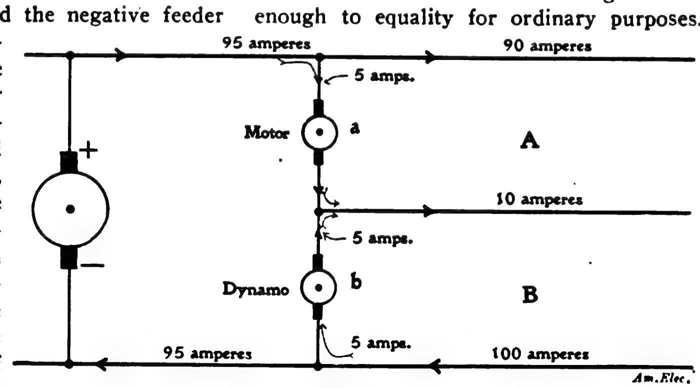
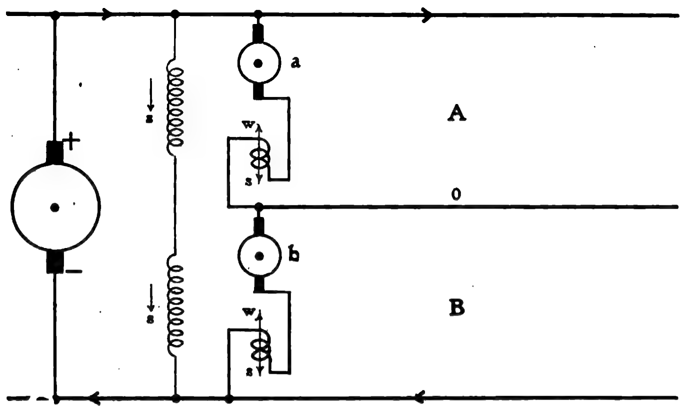


FIG. 2.

In practice, the neutral current is not divided equally between the two balancer armatures because of the losses in them. The armature which acts as a motor must receive more current than the current delivered by the dynamo half of the pair. But inasmuch as the voltage is not maintained exactly equal on both sides of the neutral, the departure from equality of current division is less than would appear. On account of the drop in the armatures, the motor half must be supplied with an e.m.f. greater than that delivered by the dynamo half, both of them running at the same speed and with equal field strengths. The difference between the two voltages, also, is increased by the unequal division of current between the armatures; the current in the motor half being greater than that in the dynamo half, the drop is greater. However, machines of very low armature resistance will maintain the voltages near enough to equality for ordinary purposes.

In order to make the equalization perfect, the balancer machines are frequently compound-wound, the series windings being so connected that the machine taking current as a motor will have its field weakened by the series winding while its mate, the dynamo, will have its field strengthened by the current passing through it. Such an arrangement is indicated diagrammatically by Fig. 3, which shows a balanced lead con-

dition. If the load be decreased in "A" or increased in "B," current will flow toward the neutral through both armatures and series field windings, weakening the field of *a* and strengthening that of *b*. If the load be greater in "A" than in "B," current will flow *from* the neutral through the two ar-

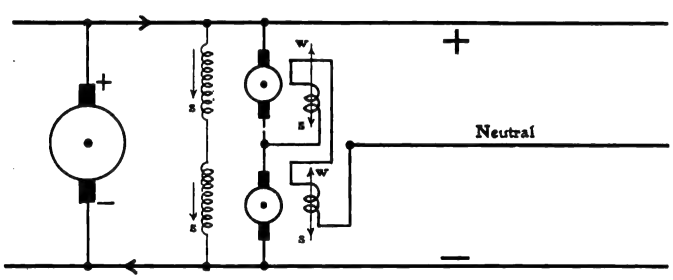


Current in the direction s strengthens the field; current in the direction w weakens it.

FIG. 3.

matures; *b* then running as a motor, with a weakened field, and driving *a* as a dynamo with a strengthened field, the current through both being opposite to its direction in the other case of unbalancing.

With the arrangement shown in Fig. 3 the effects of the series windings of the balancer machines will be unequal because the



The double arrows s ⟷ w refer to currents in the series field coils.

FIG. 4.

currents in the two machines are unequal, as already explained. Fig. 4 shows an arrangement for correcting this disadvantage which was described to the writer several years ago by the editor of the AMERICAN ELECTRICIAN. Here, the series windings are

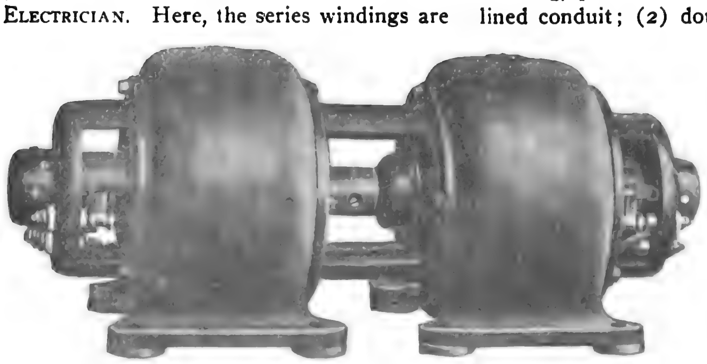


FIG. 5.—MOTOR BALANCER

connected oppositely in the neutral lead from the machines; consequently the weakening and strengthening effects are exactly equal because the same current flows through both windings.

THE WEAKEST POINT IN AN ELECTRICAL SYSTEM.

BY ELMER E. WARNER.

From the practical point of view a laboratory insulation test on an electrical appliance is no more determinative of its safety than the sign "harmless" above the kennel of a sleeping bulldog.

Every experienced electrician knows that there are two factors which chiefly fix the risk in every part of an electric system; namely, (1) the working conditions under which the appliance is installed and used, and (2) the element of deterioration. If a factor of safety could be deduced which would cover the additional risk due to the special conditions under which the appliance is used, such as dampness, inaccessibility, excessively warm location, liability to mechanical injury, etc., and another which would represent the yearly decrease in efficiency or deterioration toward the safety limit, one could determine within reasonable bounds what the initial standard should be.

Thus, instead of requiring a common insulation test a minmum should be fixed for the most favorable conditions in common practice and percentages added for, say, the two additional classes of higher risk.

Taking the primary or factory insulation of ordinary copper wire as a fundamental illustration, there are: (1) Single-braided wire with a secondary insulation of wood molding, porcelain cleats, circular loom, or lined conduit; (2) double-braided wire, the additional braid giving the added percentage of insulation necessary to protect the wire from mechanical injury in fishing through conduits or where exposed as ordinary portables; (3) a triple-braid or steel armor used with no secondary insulation, and where wires are exposed to great mechanical strains and wear, such as portables around engine and fire rooms and in buildings under construction, etc. Giving as great an increase in insulation as practical for these portable extensions of the system, one must still add a much greater percentage for deterioration. Where a single-braided wire in molding may be safe for ten years, a portable may not be for one.

The greater risk to the flexible cord dangling in the air and frequently hung over gas pipe and twisted around nails or wood projections is clearly recognized by the underwriters in the demand for an extra covering or reinforcement. The element of human depravity, of carelessness and mischievousness enters here as a large item in the risk. The writer recalls one embryo electrician in particular whose chief delight it was to short-circuit a testing line and blow the fuses when some unsuspecting companion was working near the block.

This greater risk in the more exposed parts of the system is slightly reduced by the fact that such parts and places are under direct observation, but it still remains the weakest part of the system and fixes the period between inspections.

Inspection to be of the greatest value should cover the weakest point in the system and that, as collected data show, is not in new work under the latest rules, but old work which was done before rules were formulated or respected.

The most frequent violations are as follows:

Open-link fuses or fuse wire, or fuses of solid copper or fuse wire too heavy to protect circuit from dangerous overheating.

Flexible cord twisted around metal supports, particularly gas fixtures and grounds. Flexible run on ceilings or sidewalls in place of fixed wiring. Joints in flexible cord generally unsoldered.

Unsoldered joints in circuit wiring and partial breaks and defective insulation, particularly behind old fixtures and in damp locations, such as basements, toilet rooms, etc.

Crepe paper or inflammable draperies in contact with incandescent lamps.

ARMATURE TESTS IN REPAIR SHOPS.

BY ARTHUR B. WEEKS.

Not every armature winder has a room in which to carry on his work; should this be the case, strike off a partition somewhere, running a trolley tap into the improvised room, as shown in the accompanying sketch. The wire should be run through a porcelain tube where it passes through the partition wall, and be anchored to an insulator at the further side of the room.

Next fasten a fuse block to the wall, making up a wooden support for this and for the switch and rheostat, should the side of the building be of corrugated iron. Should there be no rheostat to spare, rig up a tank or barrel for this purpose, locating it in a pit below the floor line, should there be such a pit available.

Place the armature to be tested on a support as shown, and on a nearby table a direct-current ammeter of 0 to 150 amperes capacity, and a voltmeter of 0 to 600 volts on one scale, and 0 to 10 on the other.

Make connections as shown. A support is necessary for the brush holder yoke, so that it may occupy the same relative position as in the motor. This is shown in Figs. 1 and 2. Fasten it to the "horse" with wood screws. Use the holes in the brush holder yoke for its support. Allow clearance between the armature shaft and the support, if made of iron; otherwise the readings will be misleading.

Before testing it is necessary to say more about the voltmeter. A regular meter reading 0 to 550 or 600 is entirely satisfactory for some tests, but is not sensitive enough between 0 and 5 for testing bar to bar on the commutator, one from 0 to 10 on a second scale being best adapted for this purpose. There are three binding posts, one for a common connection, one for the 600 scale, and the other for 10 scale. Do not make a mistake in the binding posts when testing.

Everything being ready, with brushes ground to a good fit, close the switch and turn on the rheostat until a current of about 40 to 50 amperes passes; the rheostat will stand this for some time. Now, suppose the armature has been completely rewound, and one desires to know if there are any cross connections, or if short-circuits exist in the commutator or coils. With the voltmeter connected for the low reading scale, make contact, bar to bar, pushing the armature over a little at a time, to reach each of the bars in turn. Begin on either side, as most convenient. If everything is normal, the reading will be anywhere from 1 to 4 volts, depending upon the character of the winding and the points where the voltmeter is applied to the commutator. If the voltmeter shows zero, there is a short-circuit. This is usually caused by solder having run down the back of the commutator when soldering in the leads, and by this test it may be located and removed in a few moments. Use a scratch awl for removing the solder.

To test for a grounded armature, which should perhaps be the first test made, since the above test made on a grounded armature might seriously injure the insulation, the ammeter is not required at all. Disconnect the lower wire from the rheostat and armature, and take out the brushes, connect as in Fig. 3, and touch the commutator with the free end, *C*. Whatever

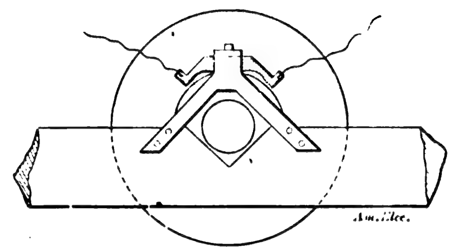


FIG. 2.

reading there is shows leakage. Touch the free end, *C*, on the armature shaft and the full line voltage is obtained.

If a ground exists, disconnect the leads of the coils from the commutator bars affected, and further probing may trace the trouble to a coil grounded on the core in its slot, or it may be the commutator is grounded. If the grounded armature has been just taken out of service, the chances are that the commutator will show by discoloration the part affected.

Before testing from bar to bar for any fault, it is a good plan to sandpaper the entire commutator thoroughly. On any railway motor commutator that has been used at all, one can get a ring with a magneto from bar to bar all around it after it has been entirely disconnected, or if five lamps in series are used for testing, they will light up. In most cases this is caused by carbon dust, though in some cases it has been traced to a too free use of fluid acid flux. The writer recalls a case where a commutator of a 500-h.p. machine had its mica insulation ruined by the too lavish use of fluid flux which attacked the copper to such an extent that the commutator required an entire dismantling, the bars cleaned, and new mica segments inserted. All manner of schemes were first tried for correcting the trouble, but without avail. The motor was tried with current, after having been first connected, but the commutator grounded on the inside and burned a great hole before the machine was pulled off the line.

There are easy formulas used in connection with these meter tests, which can be easily worked out by anyone. Take, for example, the ground test, where the voltmeter is in series with the armature. If one has never connected a meter in this way and is not familiar with testing instruments, he may have an idea that the current may burn it out. This is erroneous, as the resistance of the voltmeter is very high, about 80,000 ohms, and prevents any rush of current.

It is best to test electric apparatus when warm. If a commutator has been repaired and fresh shellac or varnish used in the segments, bake the moisture out either before or after the commutator is connected, and always test after baking. The use of the voltmeter in testing for faulty field coils gives one a sure test. It is a great saver of time and material; for without its use it is no uncommon thing to be compelled to tear out coils and dig into them one after another, before the right one is found. And often after all this expense, the coils have been found all right and the trouble located elsewhere. The proper instruments should, therefore, be provided for the careful testing of apparatus in every well regulated electric light or railway plant.

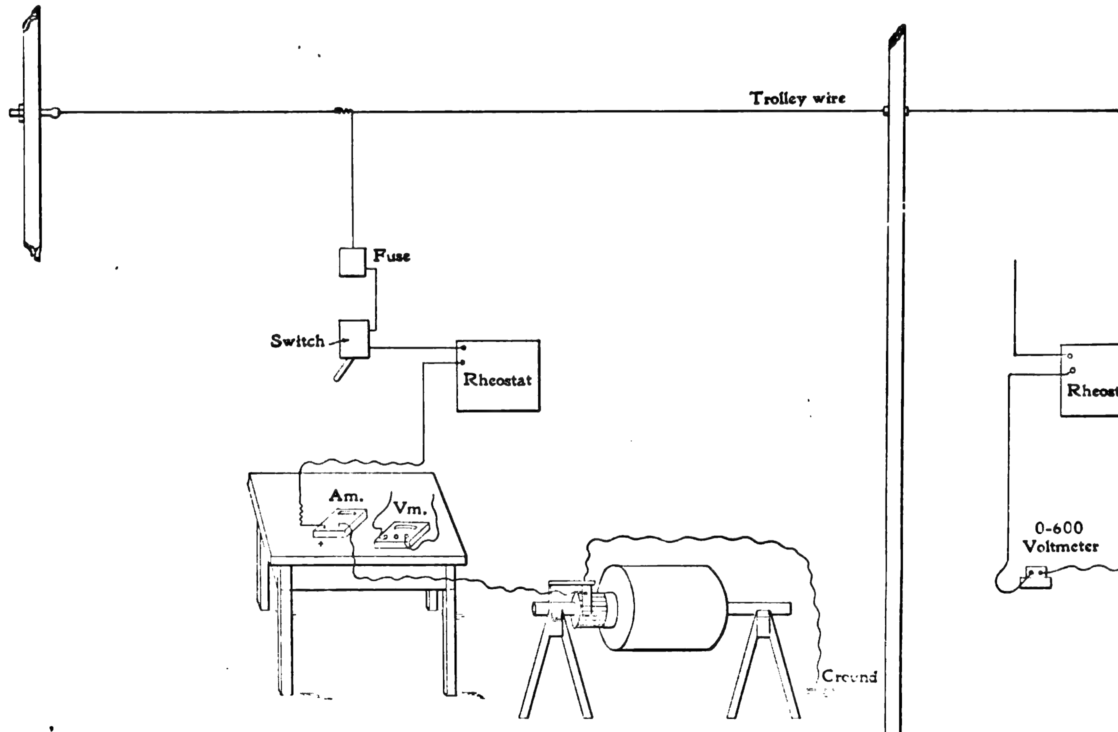


FIG. 1.

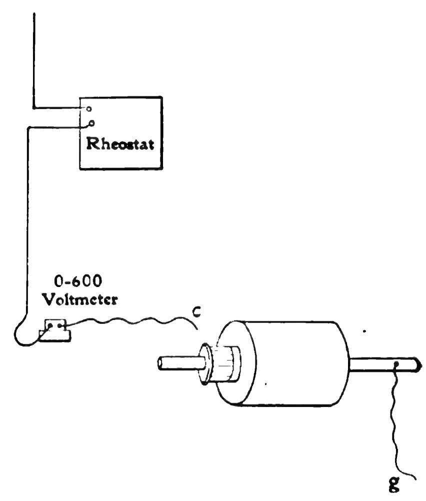


FIG. 3.

GROUNDING DISTRIBUTION SYSTEMS.

Although the grounding of secondary alternating-current circuits and the neutral feeders of three-wire systems is not positively required by the fire underwriters, it is generally conceded to be practically as important as though actually required. There is little doubt that such practice will ultimately be compulsory. Even if the fire risk be ignored, human safety requires that distribution circuits should be grounded in such manner as to minimize the difference of potential between other grounded objects and ungrounded parts of the circuits.

Three-wire systems should be thoroughly grounded at the neutral conductor in as many places as practicable. The neutral bus-bar on the station switchboard should be connected to the nearest water main; the neutral terminal of the entrance cut-out of every building should be similarly grounded, and it is a good plan also to connect the gas piping and any steam piping that may be in a building to the water piping, so that all foreign metallic systems with which persons can come into contact will be at the same potential as the neutral conductor of the electric lighting or power circuits. By this means the maximum possible voltage to which one can be subjected is the voltage between the neutral conductor and one of the outer conductors of the heavy current system. Should one of the main conductors become accidentally grounded, that conductor and the neutral conductor will be connected through the grounds and the fuses will, or should, blow. Even if at first the neutral fuse alone blows, the grounded main and the neutral feeder from the station will be short-circuited and the main fuse must blow immediately after the neutral fuse; as a matter of fact, the two will "go" so nearly simultaneously that the time difference is indistinguishable. This may be readily understood by reference to Fig. 1. Leaving out the question of fuses, however, if the neutral conductors throughout a system are well grounded, an accidental ground on either of the mains will put that main and the neutral conductor at equal potential (practically), and the maximum potential within reach of anyone will be that between the neutral conductor and the ungrounded main conductor. If the neutral is not grounded, an accidental ground on either of the main conductors will make it possible for anyone to receive the full over-all voltage of the system by touching an exposed terminal post or other device that is connected to the ungrounded main while standing in a wet spot or in contact with water piping.

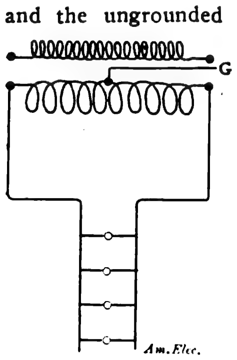


FIG. 2.

Secondary alternating-current systems should be grounded in much the same way as just described; if the distribution is on the three-wire plan, the neutral lug of the entrance cut-out should be grounded, but if two-wire distribution is used, the middle point of the transformer secondary winding should be grounded, as indicated in Fig. 2. With three-wire distribution, and a transformer on each side of the neutral, the middle point of the transformer secondary cannot be grounded because that would short-circuit all of that part of the secondary circuit between the central points

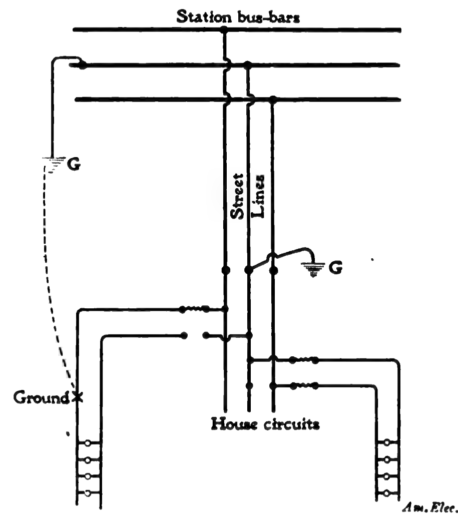


FIG. 1.

of the two transformers, as indicated in Fig. 3. The best plan is to use three-wire transformers and ground the middle terminal, when three-wire distribution is used.

When two-wire distribution is employed and it is impracticable to ground the middle point of the transformer secondary winding, one terminal of every transformer should be securely grounded so that in the event of a break-down of the insulation between the primary and secondary windings the primary circuit will be grounded; then if it is accidentally grounded elsewhere (the writer never saw a primary circuit actually free from ground leakage) either the fuses will blow or the secondary circuit voltage will not be raised. This will be evident from a consideration of Fig. 4; if the reader will mark any point on the primary circuit as being accidentally grounded so as to increase the potential between the secondary circuit and the ground, he will find that the accidental primary ground produces a short-circuit through at least one of the transformer primary fuses.

Transformer cases should invariably be thoroughly grounded; this increases the burden of the manufacturer and imposes upon workmen who have to make transformer connections the necessity of being extra cautious during the making of such connections. But it protects everyone, after connections have been made, from shock due to primary leakage and accidental contact with the transformer case.

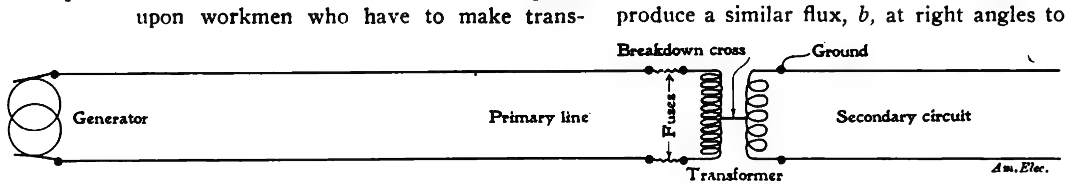


FIG. 4.

Principles of Electrical Apparatus

ACTION OF AN INDUCTION MOTOR ARMATURE OR ROTOR.

Two coils disposed at right angles on a single core, such as an armature core, and supplied independently with two alternating currents differing in phase by a quarter cycle, will produce a bipolar magnetic field that will rotate in a circle concentric with the core. Now, if the coils be mounted with a ring-shaped core, as in Fig. 1, the result will be precisely the same except that the magnetic poles will be manifested on the in-

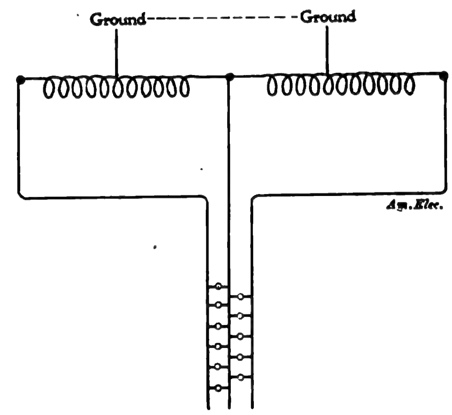


FIG. 3.—GROUNDING DISTRIBUTION SYSTEMS.

terior of the ring. Such an arrangement would be designated a bipolar field, because the two fields produced individually by the two windings combine in a single rotating field within the ring, whose axis is diametrical with regard to the hole in the ring. The construction indicated, however, is not practical; in order to allow the insertion and removal of an armature, each of the field coils must be divided into two, and the four resulting coils disposed somewhat as indi-

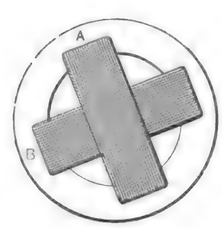


FIG. 1.

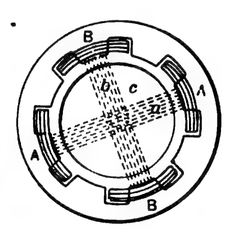


FIG. 2.

cated by Fig. 2, so that an armature core, *c*, may be inserted in the central hole.

In this event the two coils marked *A* assist each other in producing a flux, *a*, across the central core, and the coils marked *B* produce a similar flux, *b*, at right angles to this, the two combining in a single rotating field as before. Thus, with maximum current in *A* and *A*, the current of *B* and *B* will be zero and a flux will be produced as indicated in Fig. 3; when the current in *A* and *A* falls to 0.707 of its maximum, that in

B and *B* will have risen to exactly the same degree, and the resultant flux will occupy the position shown in Fig. 4. At the next eighth of a cycle the current in *A* and *A* is zero and that in *B* and *B* is maximum, locating the flux as shown in Fig. 5; and so on, through the complete cycle, as indicated by Figs. 6 to 11. In these diagrams for simplicity the flux is represented by only two dotted lines which indicate its general direction across the core and its division in the ring. With the elementary construction shown, there would be a leakage flux around the sides of the coils, as indicated in Fig. 11; for the present we must neglect this.

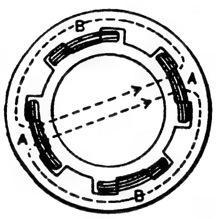


FIG. 3.

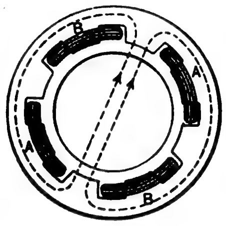


FIG. 4.

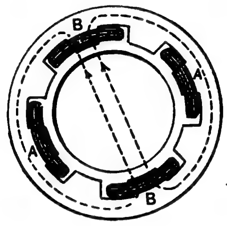


FIG. 5.

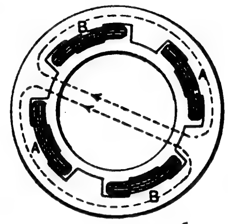


FIG. 6.

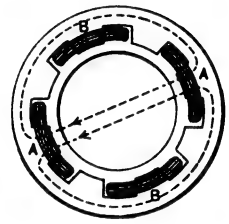


FIG. 7.

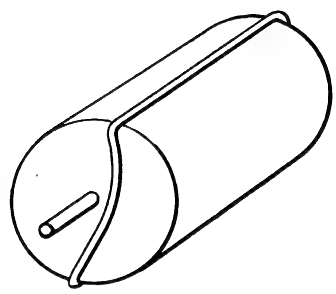


FIG. 12.

Now suppose a single turn of wire be wound on the drum core, as shown by Fig. 12, and the ends connected to form a closed circuit. If this core be inserted in the ring and held still while two-phase currents pass through the coils, the rotating field will be cut by the two wires on the drum every time it makes a revolution, and will induce in each side of the loop an e.m.f. equal to

$$e = \frac{2.22\ \Phi\ rps.}{100{,}000{,}000},$$

where *rps.* is the number of revolutions per second made by the flux and Φ is the number of magnetic lines passing through the drum. Consequently the total e.m.f. induced in the loop on the drum will be

$$E = \frac{44.4\ \Phi\ rps.}{100{,}000{,}000} \quad . \quad . \quad . \quad (1)$$

The e.m.f. thus induced causes a current to flow in the armature loop, the magnitude of which, ignoring self-induction, will be determined by Ohm's law. The e.m.f. and current in the loop will, of course, be alternating, because the direction of the flux is reversed at every half revolution. Now, if the current attained its maximum value at the instant when the sides of the loop had been swept by one-half of the flux, the flux would exert a dragging effort on the wires tending to rotate the drum with a force equal to

$$\frac{2\ I\ l\ \mathrm{B}}{11{,}303{,}000}\ lbs.;$$

the current being represented by *I*, the length of the drum in inches by *l*, and the density in magnetic lines per square inch in the air-gap by B. The numerator contains the figure 2 because there are two active conductors at the periphery of the drum. Armature reaction and self-induction in the armature winding, however, have the effect of reducing the torque to a value much smaller than this formula would make it. A general formula might therefore be written thus:

$$T = \frac{w\ i\ l\ \mathrm{B}\ k}{10{,}000{,}000} \quad . \quad . \quad . \quad (2)$$

in which *T* is the torque in pounds; *w* is the number of wires around the periphery; *i* is the current per wire; *l* is the length of the core; B is the magnetic density in the air-gap, and *k* is a number covering the effect of armature inductance and reaction and the change in the denominator.

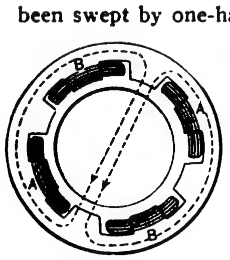


FIG. 8.

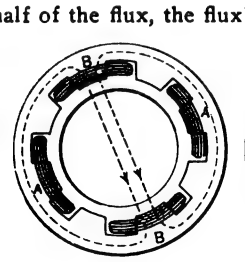


FIG. 9.

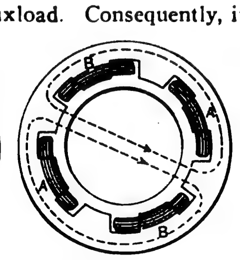


FIG. 10.

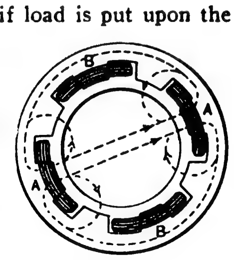


FIG. 11.

It is evident, however, that if the drum is left free to turn, the pull exerted by the rotating field upon the sides of the loop will drag the drum around. It will be also evident upon reflection that as soon as the drum begins to revolve, the wires on it will not cut so many lines of force per revolution as before, but will cut only a number proportional to the difference between its own speed and that of the rotating magnetism. Consequently, the e.m.f. induced in the armature loop will become less as its speed increases, and the armature current and torque will also become less; this will be clearer if the reader will consider that if the drum were driven by a belt at a speed equal to that of the magnetic field the sides of the loop would not be cutting any flux and there would be no e.m.f. induced in it. The operation of an induction motor, therefore, requires that the speed of its armature must be less than that of the rotating field by an amount sufficient to allow the armature conductors to cut the flux at a rate that will induce an e.m.f. in the conductors which will force enough current through them to give the requisite pull or torque to carry the load. Consequently, if load is put upon the armature, its speed will be reduced until the current flowing will be sufficient to give the required torque.

For example, still assuming the ideal condition of no lag by the armature current, and no armature reaction, if the speed at which the magnetic field rotates be 60 revolutions per second and the armature speed, running free, be 59.85 revolutions per second, the armature wires would cut 0.15 or 15 per cent of the total flux per second. Now, if the armature should have a load put upon it equal, say, to 20 times its friction load, the speed would be reduced until the wires would be cutting 20 times the number of lines of force previously cut; that is, the total flux would have to be cut $0.15 \times 20 = 3$ times per second. Consequently, the difference between the speed of the armature and that of the magnetic field would have to be 3 revolutions per second, which would bring the armature down to 57 revolutions. The difference between the armature speed and that of the rotating magnetic field is called the "slip," and it is usually written as a decimal but referred to as a percentage. Thus, in the case just mentioned, with the armature making 57 revolutions per second while the speed of the magnetic field is 60 revolutions, the difference of 3 revolutions per second is the slip, and its numerical value is $3/60 = 0.05$; it would be referred to as a slip of 5 per cent.

As stated in the beginning of this article, the resultant rotating field due to the combination of two (or more) alternating-current fields of different phases will have the same number of poles as each of the component fields. For example, in the elementary machine under consideration the flux set up by each pair of coils gives a bipolar field, and the two fluxes combined give a resultant rotating field which is also bipolar. Consequently, when one speaks of the number of poles on an induction motor it is always the number of poles *per phase* that is meant, which is equivalent to the number of poles of the resultant field formed by combining the two (or more) phases. The rotating magnetic field makes one revolution during each cycle of the magnetizing currents if the field is bipolar; the speed for more than two poles therefore would be

$$\frac{2\ f}{p} = rps. \quad . \quad . \quad . \quad (3)$$

in which *f* is the frequency of the supply current in cycles per second, and *p* is the number of poles.

As previously stated, the e.m.f. induced in the armature conductors will be alternating, and the frequency of this e.m.f. will vary inversely as the speed of the armature. The reason for this apparently contrary variation will be evident upon a little reflection. If the drum should be held stationary, the e.m.f. induced in the conductors by the rotating flux will have the same frequency as the supply current, but if the drum be driven by a belt at the same speed as the

flux there will be no e.m.f. induced because the wires will "cut" no magnetic lines of force, and the frequency will therefore be zero. The frequency of the e.m.f. in the armature conductors is given by the formula

$$f'' = f \times s \quad . \quad . \quad . \quad (4)$$

in which f'' is the frequency of the e.m.f. in the armature conductors, f is the frequency of the supply current, and s is the slip expressed in terms of the frequency. For example, an armature running at 57 *rps.* in a bipolar field produced by 60-cycle currents, would have a slip, as previously explained, of 0.05. The frequency of the current in the armature conductors, there-

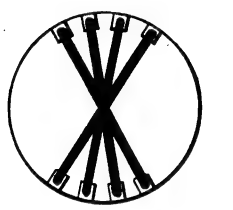


FIG. 13.

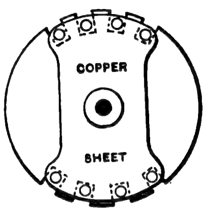


FIG. 14.

fore, would be $0.05 \times 60 = 3$ cycles per second.

Formula (2) shows that multiplying the number of conductors on the armature core will increase the pull or torque. Thus, a core wound with four loops as in Fig. 13, would have four times as many conductors on its surface as the one shown by Fig. 12, and the current would be the same in each conductor because every loop has the same e.m.f. induced in it and is of the same resistance. The torque, therefore, would be practically four times as great. It would make no difference whether the loops were kept separate or connected in series, or in parallel as in Fig. 14; the latter construction is the simplest.

As previously shown, the speed of the armature is nearly equal to that of the rotating field, lacking only the small amount represented by the slip, and the field speed, or synchronous speed as it is termed, is $\frac{2f}{p}$ revolutions per second or $\frac{120 f}{p}$ revolutions per minute. The frequency (f) ordinarily is 25, 30 or 60 cycles, so that a bipolar motor with a slip of 5 per cent would have an armature speed of 1425, 1710, or 3420 r.p.m., according to the frequency, the most common frequency being 60 cycles. These speeds are, of course, too great for motors of any size, so that bipolar construction is seldom if ever used. The smallest machines are usually given four poles, and the number increases with the size of the machine and the frequency for which it is intended. The armature for a four-pole motor, evolved from the bipolar form of Fig. 14, would be constructed as indicated in Fig. 15. However, as there is no tendency for the currents in the two windings to interfere with each other, there is no reason why the two groups should be insulated from each other, so that the construction used in practice is made as shown in Fig. 16—the "squirrel cage" type.

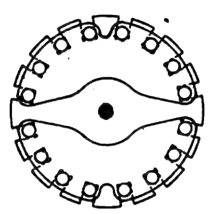


FIG. 15.

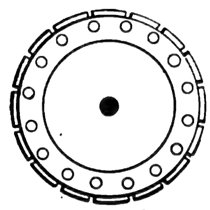


FIG. 16.

Letters on Practical Subjects

Curious Phenomena Resulting From Electric Discharges.

I enclose herewith a photograph which may be of interest to your readers, the circumstances surrounding the case being rather peculiar. One of the secondary leads from a large coil passed within six inches of an upright post on another instrument. During some experiments in wireless telegraphy considerable leakage was noticed and with every discharge a slight click was heard. This noise was finally traced to a discharge passing from the lead to this instrument. In order that better insulation might be had, a beaker was placed over the top of the post and the wire secured a little farther away. The discharge was not then so distinct and appeared to come from another point in the lead, although it could not be found, the insulation being very high. After the series of experiments the beaker was taken off the post, but to our surprise was freely spotted with small white spots. The beaker was placed on a shelf and was not touched again for two days. As a further surprise it then presented the appearance shown in the photograph, the bottom and sides for a distance of one decimeter from the bottom be-

FIG. 1.—FRACTURED BEAKER.

ing literally honeycombed with small irregular fractures. The photograph does not show the shape of these spots very well, but they are between one and two centimeters in length and very irregular in shape. None of them extend far enough to intersect one another. Although some time elapsed during the development of these perforations, no apparent change has taken place during the many months that have elapsed since.

Quincy, Mass. R. G. GRISWOLD.

A Curious Transformer "Deposit."

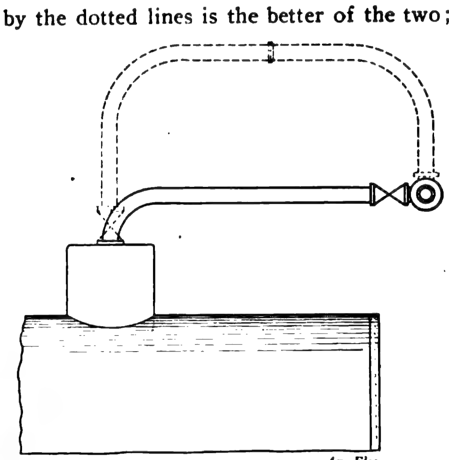
I enclose in this letter some globules of copper which were found in the bottom of the case of a large oil transformer that burned out some time ago. We found a large number of perfect balls of copper about the size of "BBB" shot and smaller, and we were much puzzled with their lightness. On cutting them open we found that they were nothing but perfect hollow globes or balls. They were given to different parties before it occurred to me to write to you, so cannot send you any good samples. It probably is a common occurrence, but it is the first time that I have noticed anything of the kind.

F. O. BROILI.

Virginia City, Nev.

Boiler Connections.

The accompanying sketch shows two methods of arranging the delivery pipe leading from a boiler to the main steam header. I have contended that the method indicated by the dotted lines is the better of the two;



BOILER CONNECTIONS.

others argue in favor of the arrangement shown by solid lines. I should like to have readers of the AMERICAN ELECTRICIAN state their preferences, giving the reasons for them.

M. E. WALTHALL.

Coalton, W. Va.

Storage Battery Operation.

In an installation of storage batteries used in conection with telephone switchboards I have noticed that the batteries are charged until the voltmeter indicates 20 volts on an 8-cell battery, or 2½ volts per cell immediately upon disconnecting the battery from the charging circuit, the voltage fell to 17½ volts. I have looked up the subject of storage battery charging in all the available text books and articles, and find that none of them states definitely whether the battery should be charged until it shows 2½ volts per cell *disconnected*, or that voltage before

disconnecting from the charging circuit. My experience is that batteries are handled by many men who are not quite clear on that point, and it seems to me that discussion of it might be of interest.

R. P. BRYAN.

Walla Walla, Wash.

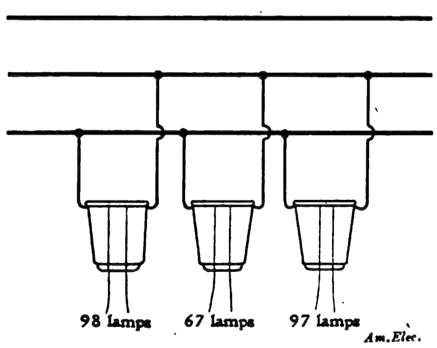
[The voltage at the terminals of the battery is not the only criterion as to the time to cease charging it, although in most cases it is a sufficiently effective guide. When it is made the deciding factor, it is, we think, generally understood that the 2½-volt limit is intended to mean the voltage just before disconnecting from the charging circuit. It is very doubtful that a battery could be charged to such a point as to enable it to give 2½ volts per cell *after* removal from the circuit.—EDITOR.]

A Transformer Trouble.

Three transformers connected to the same phase of a two-phase primary circuit behave in a peculiar way. The transformers are of 100 lights capacity each, and the normal loads are 98 lamps on *A*, 67 lamps on *B* and 97 on *C*. When a group of 17 or 18 lamps is cut out from either *A* or *C*, the fuse in the circuit of *B* blows. I should like to have some of the AMERICAN ELECTRICIAN readers suggest the cause and a remedy.

ERNEST ANDERSON.

Moroni, Utah.



MR. ANDERSON'S TRANSFORMER TROUBLE.

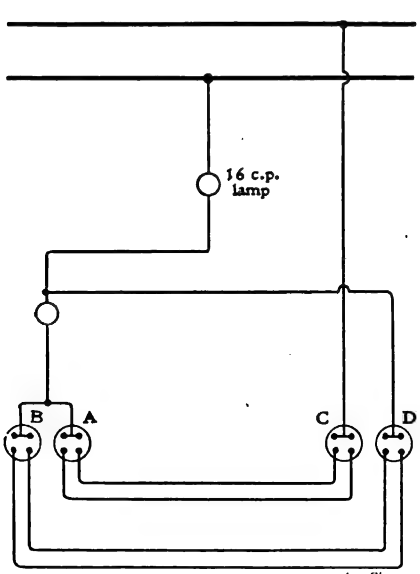


FIG. 2.—MR. DILLON'S SOLUTION.

Mr. McHugh's Problem in Switch Connections.

Enclosed is a diagram of connections (Fig. 1) submitted as a solution of Mr. McHugh's problem which appeared last month. The switches *A* and *C* control the entire lamp circuit on the familiar two-station principle; when the lamp is operatively connected to the line, either switch will extinguish it, after which either of them will relight it. The switches *B* and *D* control a short-circuiting circuit around the resistance lamp in the same way.

W. G. BRANDON.

Marion, Ind.

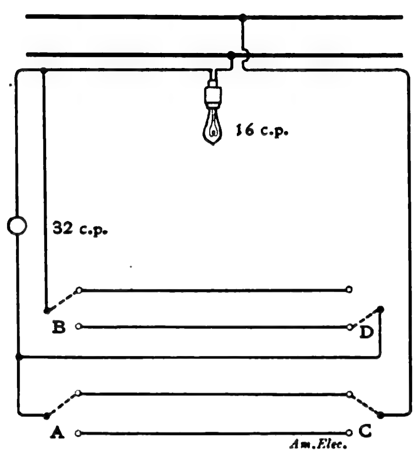


FIG. 1.—MR. BRANDON'S SOLUTION.

[Exactly the same diagram was sent in by Messrs. William Merrill, of Wilmington, Del., and H. C. Storm, of Yonkers, N. Y.—EDITOR.]

The accompanying diagram (Fig. 1) shows one way of obtaining the results described in Mr. McHugh's problem in lamp control published in the December number of the AMERICAN ELECTRICIAN. The switches *A* and *C* control the admission of current to the lamp circuit and the switches *B* and *D* control a short-circuit connection around the resistance lamp.

LAWRENCE BRODE.

Colton, Cal.

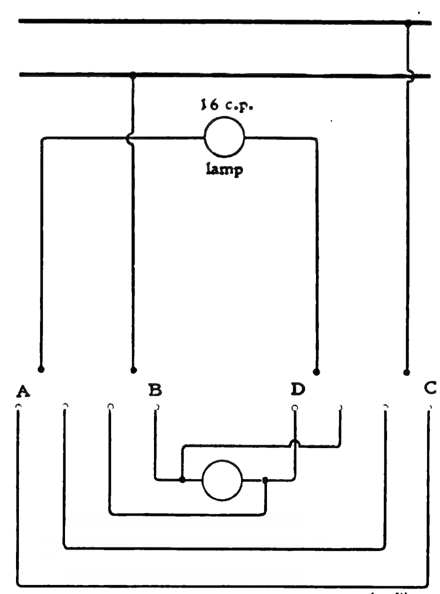


FIG. 3.—MR. EUSTACHIO'S SOLUTION.

I send herewith a solution (Fig. 1) of Mr. McHugh's problem in the December number of the AMERICAN ELECTRICIAN. The switches are all three point, or single-pole two-way, snap switches; the effect of each pair is obvious from an inspection of the diagram.

H. B. BROWN.

Schenectady, N. Y.

Herewith I submit a solution (Fig. 2) of Mr. McHugh's problem in lamp and switch connections. The switches *A* and *C* light and extinguish the lamp and the extra pair of switches simply short-circuit the resistance lamp and remove the short-circuit, thereby affecting the brilliancy of the 16-c.p. lamp.

JAMES DALZIEL.

Brooklyn, N. Y.

[This solution is practically the same as Fig. 1, there being only a slight difference in the wiring details.—EDITOR.]

The accompanying diagram (Fig. 2) is submitted as a solution of Mr. McHugh's switch-connection problem published last month. The operations are obvious.

JAMES B. DILLON.

Louisville, Ky.

Referring to Mr. McHugh's problem in lamp control, I offer the accompanying diagram (Fig. 2) as a solution. The switches *A* and *C* cut the lamp in and out of circuit successively, and when it is in circuit, the extra switches *B* and *D* short-circuit the resistance lamp in series with the regular lamp, or remove the short-circuit, thereby controlling the brightness of the 16-c.p. lamp. This is the only way I can see by which the desired results can be obtained with three-point switches.

G. F. ERFURTH.

Fort Smith, Ark.

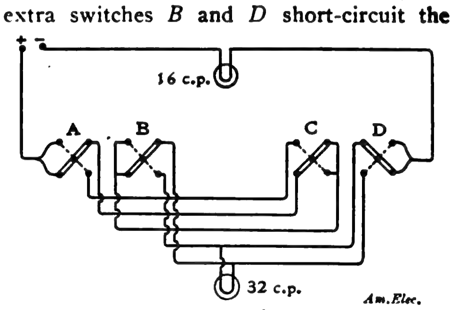


FIG. 4.—MR. FRASER'S SOLUTION.

The accompanying diagram (Fig. 3) shows one way of accomplishing the results specified in Mr. McHugh's letter last month. The 16-c.p. lamp is connected between the common points of the switches *A* and *D* and the resistance lamp is connected across the alternative leads between the switches *B* and *D*. The switches *A* and *C* control the admission of current to the lamp direct and *B* and *D* complete the circuit either from the 16-c.p. lamp direct or through the resistance lamp.

G. D. EUSTACHIO.

Pittsburg, Pa.

I submit the accompanying sketch (Fig. 4) as a solution of the problem in switch connections offered last month by Mr. Mc-

Hugh. With the switches set as in the diagram, the 16-c.p. lamp would be connected to the supply circuit in series with the resistance lamp. Turning either *B* or *D* would leave the resistance lamp out of the active circuit and allow the regular lamp

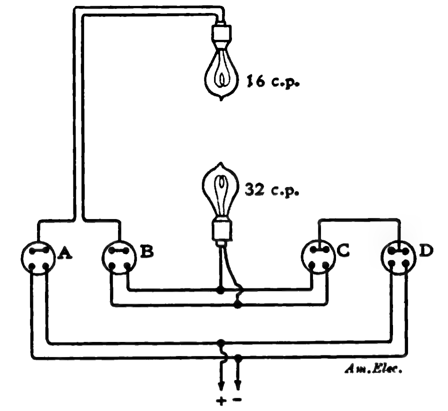


FIG. 5.—MR. FREASE'S SOLUTION.

to burn at full candle-power. Turning either *A* or *C* would disconnect the lamp circuit from the positive side of the line. Another turn of either switch would restore the conditions existing before its mate was turned.

CLARENCE L. FRASER.

Pulaski, N. Y.

The enclosed diagram (Fig. 5) is a solution of Mr. McHugh's lamp connection problem in the last number of the AMERICAN ELECTRICIAN. One terminal of the 16-c.p. lamp is connected to one or the other main line terminals by the switch *A;* the other terminal, in circuit with which are the switches *B* and *D* and the resistance lamp,

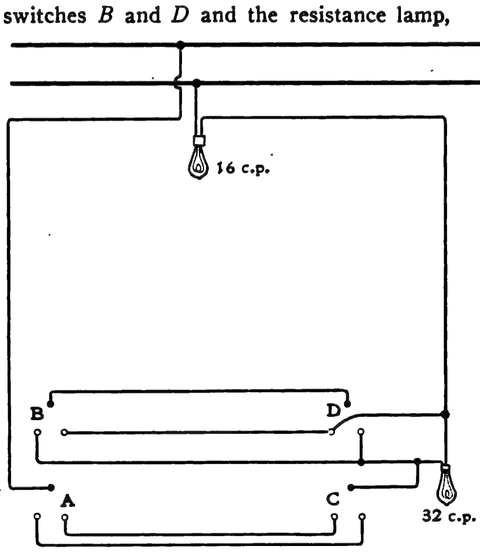


FIG. 6.

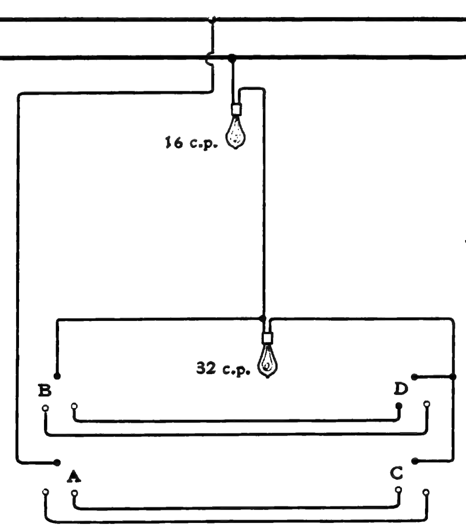


FIG. 7.

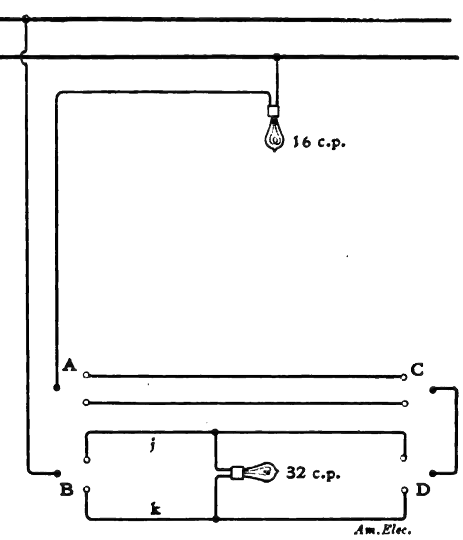


FIG. 8.

is similarly controlled by the switch *C.* The switches *B* and *D* merely determine whether the resistance lamp is in series with the regular lamp or not.

G. E. FREASE.

Youngstown, Ohio.

I send herewith (Fig. 4) a solution of Mr. McHugh's problem in switch connections which appeared in this department last month. The diagram is practically self-explanatory.

RICHARD GESSNER.

Oak Park, Ill.

[The operation is, of course, as described in Mr. Fraser's letter, preceding. The same diagram was sent in by Mr. W. H. Middleton, Jr., of Prince Bay, N. Y.—EDITOR.]

The enclosed sketches (Figs. 6, 7 and 8) indicate three ways of solving the lamp

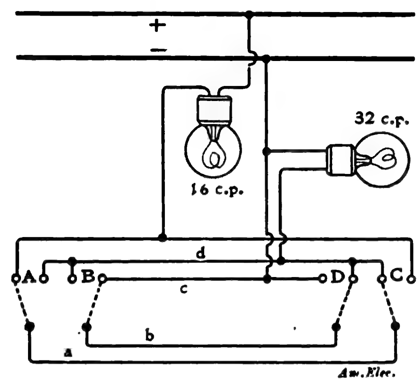


FIG. 9.—MR. M'DONALD'S SOLUTION.

and switch connection problem published in this department last month. In the first two, the resistance lamp is either short-circuited or left in circuit by the switches *B* and *D;* it is permanently in series with the 16-c.p. lamp. In Fig. 8 the resistance lamp and the switches *B* and *D,* considered as a group, are in series with the 16-c.p. lamp and the switches complete the circuit either through one of the wires *j, k,* or through half of each wire and the resistance lamp. In all three solutions, the switches are two-way, single-pole, snap switches, and those marked *A* and *C* light the lamp or put it out in the ordinary way peculiar to two-station lamp control. The last solution (Fig. 8) is the best one for several reasons, chiefly because it requires only four wires between the two stations switch instead of five.

GEORGE W. MALCOLM.

Brooklyn, N. Y.

[Fig. 8 was also sent in by Mr. M. H. Stillman, Austin, Minn.—EDITOR.]

The enclosed diagram (Fig. 1) is a solution of the lamp connection problem published last month. The three-point, snap switches are represented conventionally like battery strap switches. With the switches set as indicated by the dotted lines, the lamps will be connected in series to the supply line. Throwing either *B* or *D* will short-circuit the resistance lamp and let the 16-c.p. lamp burn at full power. Throwing either *A* or *C* will put out the lamp. Another turn of *A* or *C* will put it back in circuit with the resistance lamp short-circuited, and a

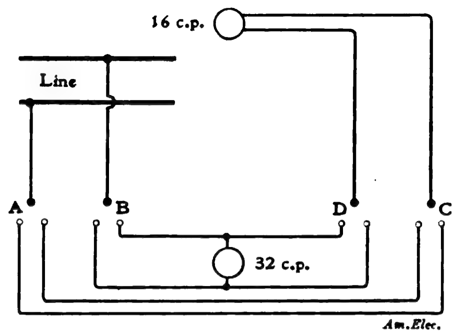


FIG. 10.—MR. MOORE'S SOLUTION.

turn of either *B* or *D* will put the resistance lamp back in circuit.

L. P. MANSFIELD.

Cambridge, Mass.

Enclosed I submit a solution (Fig. 9) of Mr. McHugh's problem in switch connections. My understanding of the problem is that the 16-c.p. lamp is to be turned on or off from either station and when on, it is to be dimmed by means of a resistance lamp or left bright, at will, from either station. Referring to the sketch, the switches are in position for the lamp to burn at full power; the current path being from + to the lamp, through switch *A,* wire *a,* switch *C,* switch *D,* wire *b,* switch *B,* wire *c,* and to the negative line. Throwing either *B* or *D* would send the current from switch *C* to the resistance lamp, and the next throw of either of them would short-circuit the resistance lamp again. The two switches *A* and *C* work on the two-station control plan; throwing either of them from the position shown would open the lamp circuit, after which throwing either of them would restore it.

L. R. MCDONALD.

Montreal, Can.

The lamp and switch connection problem

published last month can be solved by the arrangement shown by the enclosed diagram (Fig. 10). The switches are all two-way, single-pole, snap switches. One of the leads from the 16-c.p. lamp is connected to or disconnected from the line by means of the switches *A* and *C*; the other lead is connected to the line either direct or through the resistance lamp by means of the switches *B* and *D*, one or the other connection being always made. Thus, the lamp may be lighted or put out at either point of control, and when it is lighted, it may be dimmed or "undimmed" from either station.

W. H. MOORE.

La Grange, Ill.

[Exactly the same solution has been furnished by Mr. Charles B. Smeeth, of Ironwood, Mich.—EDITOR.]

The accompanying sketch (Fig. 11) shows one way of accomplishing the results described in Mr. McHugh's letter last month. The switches *A* and *C* operate in the usual way for two-station lamp control; the switches *B* and *D* either insert in or remove from the lamp circuit the resistance lamp. In the diagram, the main lamp is in circuit direct, the resistance lamp being connected to the circuit only at the left-hand terminal. If the switch *B* is thrown over, the current coming to that switch from *C* will go through the wire *m* to the junction *x*, and back through the resistance lamp, to the wire *n* and on to the switch *D* and the main lamp. If, on the other hand, the switch *B* is left as it is and *D* is thrown over, the current from *B* must pass over to *D* through the resistance lamp instead of the wire *n*; in both cases the resistance lamp will, of course, be in series with the main lamp.

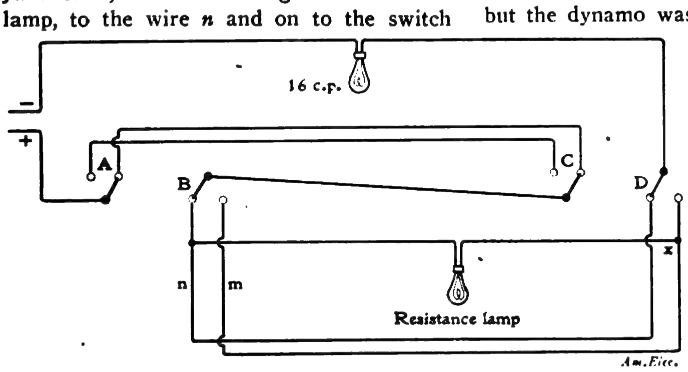


FIG. 11.—MR. RICHARDSON'S SOLUTION.

GEORGE W. RICHARDSON.

Chicago, Ill.

The accompanying diagram (Fig. 12) is submitted as a solution of the problem in lamp control which appeared last month. The switches *A* and *C* light and extinguish the lamp in the way peculiar to two-station control with three-point switches, using the wires *m* and *n*. The switches *B* and *D*, if manipulated in combination with *A* and *C* respectively change the circuit from the wire *m* or *n* to the middle wire in which is inserted the resistance lamp. For example, with the switches as shown in the diagram, the lamp is extinguished; throwing either *A* or *C* will light it at full power; or throwing either *B* or *D* will light it with the resistance lamp in series with it. When the lamp is in circuit at full power, throwing either *A* or *C* will put it out; or throwing both *A* and *B* together or *C* and *D* together will dim it by inserting the resistance lamp.

LOUIS J. GORILLA.

Ironwood, Mich.

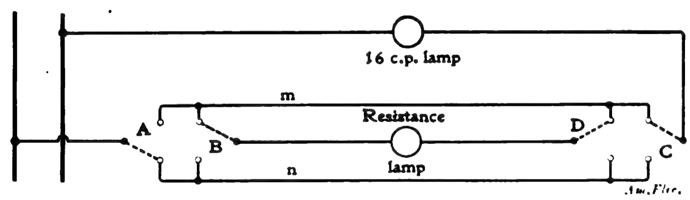


FIG. 12.—MR. GORILLA'S SOLUTION.

An Odd Dynamo Trouble.

The other day, what is I think a rather mysterious occurence, happened to me, and for the reason that I would like to have the mystery explained, and that I think that it might be of interest to some of my fellow readers, I herewith submit the facts of the case.

I was called in to see what I could do for a small dynamo that refused to "pick up" its load. The dynamo is a brand-new 10-kw., direct-current machine, with four poles, compound-wound. The four brushes are connected in the usual manner, the leads being taken off the two lower ones.

An expert was there, and had been running the machine. He said it had given no trouble until this time, when he had shut down to show the man who was to have charge of the plant something about the engine. When, ten minutes later, he tried to start up again the dynamo was "dead." I examined the connections and found them all right, and the machine free from grounds (in itself). We started up again, but the dynamo was "dead as a door-nail." I short-circuited the line, and then the rheostat, with equally negative results. I was standing over the machine, looking at the voltmeter when, accidentally, I let the screw-driver, which I held in my hand, come in contact with the two upper brush-holders. There was a flash which "fixed" the screw-driver and the dynamo, too, for it "picked up" instantly, and has given no trouble since. I examined the machine again, and could find no trace of what happened in it, except the short-circuit caused by the screw-driver.

ALBERT G. FULTON.

Oconto, Wis.

Problem in Motor Connections.

The accompanying diagram (Fig. 1) represents a 5-h.p. motor installed in a basement with a speed-regulating rheostat near it, and a starting box, *S*, on the floor above. The speed-regulating rheostat is operated automatically, so that there is no need for anyone to go downstairs in the ordinary course of operation. It is desired to install a 1/6-h.p. fan-motor near the 5-h.p. machine for ventilating purposes, and to connect it to the supply circuit so that when the larger motor is started up the little one will be started also but its speed must not

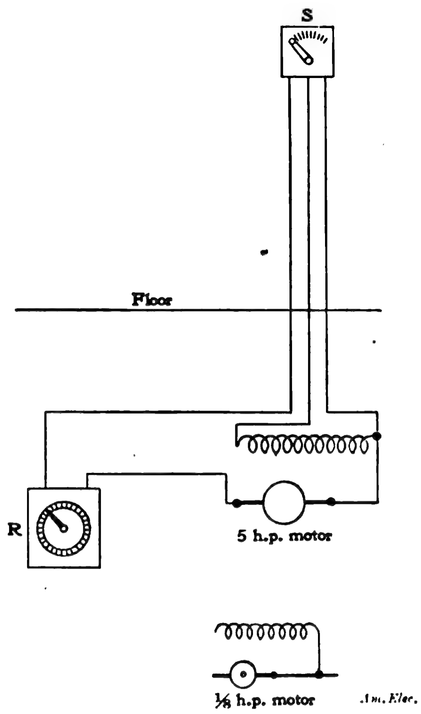


FIG. 1.—PROBLEM IN MOTOR CONNECTIONS.

be affected by the speed-regulating rheostat, *R*. After being started, it must run at full speed, regardless of the speed of the larger motor. The supply circuit enters the starting box, *S*, from above, and does not go down into the basement at all. The connections are to be made with the least possible quantity of wire. I should like for readers of the AMERICAN ELECTRICIAN to suggest the proper connections.

GEO. W. MALCOLM.

Brooklyn, N. Y.

Lamp Coloring Compound.

If any reader of the AMERICAN ELECTRICIAN knows of a good recipe for making coloring compound for incandescent lamp bulbs, I would appreciate highly the publication of it in this department. I have tried one or two recipes, but the compound does not last any length of time; the least handling or exposure to weather causes it to wear off in spots until it is practically ineffective.

K. G. LITTLE.

Atlanta, Ga.

Questions and Answers

Inquiries not accompanied by the name and address of the inquirer, will not receive attention.

What is the best way to make storage batteries? (2) How should a new battery be charged the first time? (3) Can rubber or composition jars be cemented where they have been cracked? S. E. H.

(1) and (2) The subject cannot be treated adequately in the space available in this department; "Electrical Designs" contains instructions of this kind; the price is $2.00. (3) Not satisfactorily.

How can a 6-volt, 4-ampere dynamo, with No. 16 wire in the armature and Nos. 18 and 13 in the field (compound-wound) be changed to 110 volts? (2) What will the output in amperes be? J. W. W.

Rewind the armature with No. 29 silk-covered wire, putting 19 times as many turns in each coil as there are now. Rewind the shunt coils with No. 31 silk-covered wire to the same dimensions as the present coils. Rewind the series coils with No. 26 single-cotton-covered wire, putting 19 times as many turns per coil as there are now. (2) About 0.2 ampere.

Why will a rotary converter give a greater output operated six-phase than it gives as a three-phase machine? (2) In transposing line wires to neutralize inductive effects, must the same one of the wires always cross over the other, or can the two be spiraled? (3) If spiraled, with two circuits on one pole line, should the spirals of the two circuits be in the same direction, or should one be right-handed and the other left-handed? C. E. F.

Because the disposition of currents in the armature winding is more favorable as to heating, so that more current can be carried with the same rise of temperature. (2) and (3) It makes not the least difference.

If a 6-pole motor, having a lap-wound armature with 6 paths, were operated with the field magnet coils on two diametrically opposite poles cut out of circuit and the two sets of brushes corresponding to these poles lifted from the commutator, what would be the results? The machine has equalizer connections on the armature winding. (2) What would happen if two adjacent field magnet coils were cut out? W. M. S.

Excessive currents would flow in the equalizer connections and the current density under the remaining brush faces would be excessive; it would be better to leave all of the brushes on the commutator. (2) The same results as in the first case; also an unbalancing of the magnetic field which might cause seriously excessive friction in the bearings.

Is it good practice in wiring a house already built to fish the conductors up between the walls of the first floor to side fixtures and drop the lights from the ceilings of the second floor? (2) Can both conductors of a circuit be put in one flexible conduit? (3) Should a cut-out be used on the outside of a building where wires enter it? (4) Is it common practice to use cross-arms carrying more than four pins for light and power wires? (5) Is it good practice to run an alternating-current 1100-volt circuit over and parallel to a telephone line. S. C. R.

It is so far as the wiring is concerned, but the illumination on the first floor will not be as good as with ceiling lights. (2) Yes. (3) Not necessarily. (4) Yes; 6-pin arms are frequently used. (5) It is preferable not to do so, but it is often unavoidable.

In testing a three-phase alternator with a submerged iron-wire resistance for a load, the ammeters in the three leads from the armature indicated (a) 46, (b) 74 and (c) 48 amperes respectively, at the same time. The 46-ampere lead was connected to one terminal, A, of the resistance coil, the 74-ampere lead to the exact center of the coil and the 48-ampere lead to the other extreme end, C; what caused the difference between the current in the middle lead and those in the other two? J. I. D.

The current in the lead b was the combination of the other two; if a resistance coil of half the resistance of the one used had been connected to the terminals A, C, of that one, without changing any of the connections, the three currents would have been substantially equal.

Should the field winding of a repulsion motor be a single winding, like that of a series-wound, direct-current motor, or divided into two groups like the starting and working winding of a self-starting, single-phase induction motor? (2) Is it necessary to use a continuous notched ring, as in an induction motor, or can projecting poles be used? (3) What is the relation between the field and armature windings? (4) Why will such motors not run on all frequencies? (5) Are they not the best for hoisting, ventilating fans, cranes, etc.? F. B. A.

Only one field winding is required. (2) Either construction may be used. (3) The question is obscure. The field winding is connected to the source of supply; the armature winding is short-circuited through the brushes. (4) Because of the self-induction at high frequencies. (5) Not necessarily; they are probably better than the ordinary induction motor.

Why are idle or "dead" segments sometimes put in the commutators of direct-current dynamos? (2) How does the charging current of an alternating-current transmission line raise the voltage of the line? (3) What troubles result from opening such a line when it is loaded or short-circuited? F. A. B.

Such segments are used only in the commutators of "open-coil" arc-lighting dynamos, to separate the active segments widely and prevent the "spark" at the brush from welding them together. (2) It doesn't; the electrostatic capacity of the line combined with its inductance, is what raises the voltage. It is impracticable to explain this satisfactorily here; see any text-book on alternating-current principles. (3) Unless opened at the instant when the alternating current is very near zero, a sudden rise in e.m.f. which may puncture insulation in the connected apparatus.

How can the positive and negative brushes of a multipolar dynamo be identified before carrying the leads to the switchboard? (2) Why does the negative wire of a dynamo circuit produce nearly the same effect as the positive wire when touched with the hand by anyone standing on the ground? H. H. T.

By applying a voltmeter of the permanent magnet type to the different pairs of brushes; when the + post of the meter is connected to the negative brush and the other post to the positive, the needle is thrown against the back stop; when the + post is connected to the + brush and the other post to the negative brush, the needle is deflected over the scale. (2) Because there is a leakage path to the earth from some part of the armature winding and the person touching the wires gets about the same difference of potential from either wire to the ground.

How much discrepancy is allowable between the individual voltages across different pairs of brushes on a multipolar machine? (2) In drying out a dynamo with its own current, should the machine be started up under short-circuit or should it be brought up to a low voltage before short-circuiting the armature? (3) Should the series field winding be cut out while drying out? M. S.

None; the voltage between every pair of brush groups of opposite polarity should be exactly the same. If this condition cannot be obtained without shifting some of the brushes away from the proper commutating position, the machine should be overhauled. (2) and (3) It should be started up under short-circuit through an ammeter, with the series field winding in circuit, and the shunt field rheostat cut out, provided the speed can be accurately adjusted to keep the current down; if not, the series winding should be cut out of circuit and the machine started up under short-circuit through the ammeter, with the shunt field rheostat all in.

What connections are necessary to take two-phase and three-phase currents from a lap-wound armature in a 4-pole, direct-current machine? (2) If direct-current be passed through the stator winding of an induction motor, will the polarity of the groups of teeth embraced by the successive coils be alternately north and south? F. M.

For two-phase current, connect two diametrically-opposite commutator segments and carry a tap from them to one collector ring; connect two other opposite segments exactly half-way between the first two and carry a tap to a second ring; this is one phase. Connect the other two rings to two pairs of segments exactly half-way between the first two pairs, the two segments of each pair being always diametrically opposite. For three phases, one of the collector rings of the two-phase set may be used; if the commutator segments be numbered consecutively all around the barrel, and the first two-phase ring is connected to Nos. 1 and 37, using this for one of the three-phase rings, the other two rings must be connected one to segments 13 and 49, and the other to segments 25 and 61. (2) Yes.

What is the relation between the pull of a stopped solenoid excited from a direct-current circuit and from an alternating-current circuit, the winding being the same in both cases? (2) In what part of the circuit of an induction motor should a solenoid be connected for best results? (3) In an adjustable starting resistance for induction motors, should each phase be provided with a resistance and switch contacts? (4) What is the best form of resistance to use? (5) When breaking a polyphase circuit, should all of the legs or phases be opened? (6) Can I obtain copies of the April and May, 1901, AMERICAN ELECTRICIAN, or, if not, can I get copies of the articles on windings for magnets and solenoids published in those numbers? H. W. Z.

There is no definite relation; the winding must be designed especially for alternating current. (2) That depends on what it is desired to accomplish; if the magnet is to operate without reference to the current flowing in the motor, it should be connected across two of the leads. (3) Yes. (4) For small machines thin copper ribbon arranged non-inductively for large ones, either carbon rods or a submerged rheostat having conductors of non-magnetic material. (5) Yes. (6) The numbers are out of print; the articles will be published in book form with much additional material, probably within the next three months.

POWER PLANT OF ANHEUSER-BUSCH BREWING ASSOCIATION, AT ST. LOUIS.

The electric generating plant and refrigerating machinery of the Anheuser-Busch Brewing Association in St. Louis, Mo., are located in one building having a side on Ninth Street and facing Pestalozzi Street, where the general offices of the Association are situated. The boiler house which contains a battery of eleven 500-h.p. Heine water-tube boilers is about 500 feet from the engine room. There are three main steam lines to the power and refrigerating

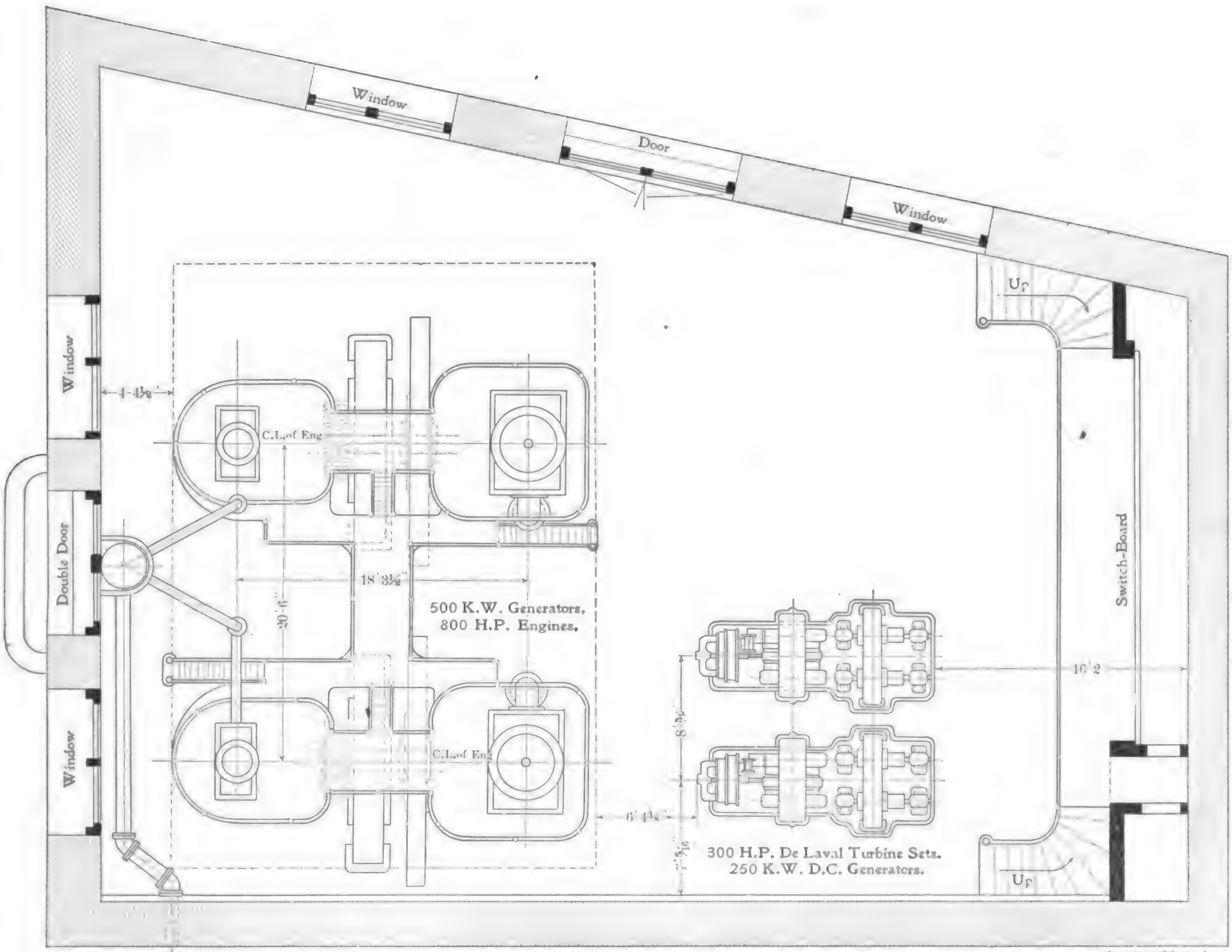


FIG. 1.—PLAN OF THE POWER PLANT OF THE ANHEUSER-BUSCH BREWING ASSOCIATION.

plant, one 18 in., one 14 in. and one 12 in.

The electric power plant consists of two 750-h.p. vertical compound Corliss condensing engines, built by the Fulton Iron Works in 1901. These engines have 21-in. and 42-in. cylinders, and a stroke of 48 ins. The steam pressure is 140 lbs., and speed 90 r.p.m. They are direct connected to 500-kw. General Electric 240-volt direct-current generators. These, with the two 200-kw. De Laval steam-turbine dynamos, give a total normal capacity of 1400 kilowatts The two 300 b.h.p. turbines are of standard De Laval type, each direct connected to a pair of 200-kw., 240-volt direct-current generators, built by the Bullock Electric Manufacturing Company, and operate under 140 lbs. steam pressure and a vacuum of 27 ins.

Fig. 1 shows in outline the general arrangement of the engine room, and Fig. 2 is a view of the turbine units. The steam guarantees given by the De Laval Steam Turbine Company in connection with these machines, were as follows:

Full load—17.9 lbs. of dry steam per B. H. P. per hour.
Half load—20.1 lbs. of dry steam per B. H. P. per hour.
Quarter load—24.9 lbs. of dry steam per B. H. P. per hour.

These guarantees were for 140 lbs. steam pressure and 26 ins. vacuum, and on acceptance test recently run the steam consumption came well within these figures, and the machines were accepted.

The normal requirements of the plant are sufficient to keep one engine and one turbine fully loaded, thereby making it possible to hold one engine and one turbine in reserve at all times.

The exhaust steam from the engines is led into a Wheeler surface condenser of 1500 horse-power capacity. Condensing water from the cooling towers is circulated through the condenser by a 10-in. Wheeler centrifugal pump driven by a 50-h.p. Bullock direct-current motor. The condensed steam and air are removed together by means of an Edwards triplex wet vacuum pump driven by a 10-h.p. Bullock motor, whose speed may be varied by means of a multiple voltage system.

The condensing apparatus for the steam turbines is a duplicate of that installed for the compound engines, with the exception of the circulating pump, which is an 8-in. centrifugal pump built by the Kingsford Foundry & Machine Works. Each exhaust line is provided with a 24-in. relief valve, which opens to the atmosphere. Cochrane separators are installed in the steam lines and numerous traps drain the piping, separators and turbine steam chambers.

The oil from the engines is drained into a filter and then pumped by means of the Siegrist automatic oiling system, to the engines, where it is fed under pressure. The turbine oiling system is independent of the engine drainage, but is essentially the same in its operation.

The electric cables from generators, after passing through and under the floor, are led through ducts behind the massive switchboard which is erected above, on the operating gallery. The switchboard is made of heavy panels of white Vermont marble and covers nearly the entire wall at one end of the engine room. There are 32 panels in all, but only 20 of them are now in use. The voltmeters and ammeters are of the Weston standard station type,

and may be read from the floor some distance below, by means of their illuminated scale. Each main and feeder circuit is provided with an I-T-E circuit breaker. The switches are all of heavy construction and neat design.

The greater portion of the load on the generators is used in driving motors distributed all over the large brewing plant, for operating automatic malting machinery, bottling machines, elevators, fans, blowers, pumps and for charging storage batteries used on the electric delivery truck. This entire plant was designed and erected under the supervision of Mr. Ernest Ruebel of Ruebel-Schwedtman-Wells, consulting engineer for the Association.

The engine room is well lighted and is one of the handsomest in the West. The walls have a wainscoting of glazed tile, and the floor is laid with tile of a pretty design. Engines and turbines are painted a deep red color, and are striped with gold leaf. An automatic Otis electric elevator is installed for the use of the attendants in going about from the condenser room, which is underneath the turbines to the floor above, where the brine-cooling coils for refrigerating machinery are located.

NEW GENERATING SET.

The B. F. Sturtevant Company, of Boston, Mass., has brought out the generating set shown by Fig. 1 herewith, which is said to embody many new features. The general design of the engine is said to include all the latest improvements to the horizontal type. The reciprocating parts are substantially constructed and counterbalanced with lead load discs. A feature of construction is that of forging the crankshaft solid in one piece and shrinking the discs onto it. A special arrangement of the Rites' governor is said to give a regulation within 1 to 1½ per cent from full load to no load, and by a modification of the Marshall valve gear an adjustment of the cut-off from zero to 70 per cent is attained. The main bearings, crankpin, valve stem and slides are babbitted with the Sturtevant white metal. A recent improvement is the water-shed partition which prevents the water from the piston rod stuffing box from reaching the interior of the engine frame, and the oil on the reciprocating parts from being thrown out into the engine room. The main body of the engine is enclosed on both sides by removable plates, as may be seen from the illustration, and the crank webs are enclosed by a cast-iron hood having two holes with removable covers, one for the purpose of cleaning the crank-pin box while it is in motion, and the other for removing the box without taking off the large hood. Between the watershed partition and the front end of the cylinder, is a hand hole for reaching the stuffing box bolts without communication to the oil spaces. There are two oiling systems for this type of engine, the gravity or tank system and that by forced pump lubrication. The generator of this set is of the eight-pole type, and is said to be capable of carrying momentary overloads of 50 per cent without any shifting of brushes or flashing of the commutator, and an overload of 25 per cent for a period of two hours without undue heating. The average temperature rise is about 33 to 35 degs. C. Before being shipped, the generator is given a break-down test of 1500 volts, alternating for sixty seconds between the conductors and the frame of the machine to test the insulation. The magnet frame is of cast iron, split horizontally. The pole pieces are of wrought iron with cast iron shoes, and are secured to the magnet frame by through bolts. Any of the pole pieces may thus be removed to repair the field coils. The latter are wound up in two sections, with an air space between the shunt and series coils. The shunt winding is a double cotton-covered magnet wire, the series winding is of solid copper bars insulated in the same manner as the shunt coil. The armature is of the ironclad, form-wound, ventilated-drum type, having a core built up of charcoal iron plates, which after being thoroughly Japanned are mounted upon a cast iron spider and securely held in position by end flanges. No bolts pass through the armature laminations. The armature spider has an extension upon which is mounted the commutator making the armature and commutator one unit. The armature conductors are solid copper bars, without joints, except at the commutator end. In the construction of the commutator only drop-forged or drawn segments are used, these being secured in cast iron shells of spider construction and clamped in place with a steel ring. No cast segments of any nature whatever are used. The segments are insulated with mica, the end insulation consists of micanite rings and the whole commutator is assembled while hot, under pressure. Carbon brushes only are used, the commutator being so proportioned and the brushes of such size as to allow at least one square inch of brush area to every 30 amperes carried. These brushes are carried in holders of approved construction, each mounted upon a self-contained brush rigging so arranged that the entire set of brushes may be rotated completely around the commutator. Hand wheels are furnished for adjusting the brushes in position, these hand wheels being so located that the brushes may be adjusted from either side of the generator.

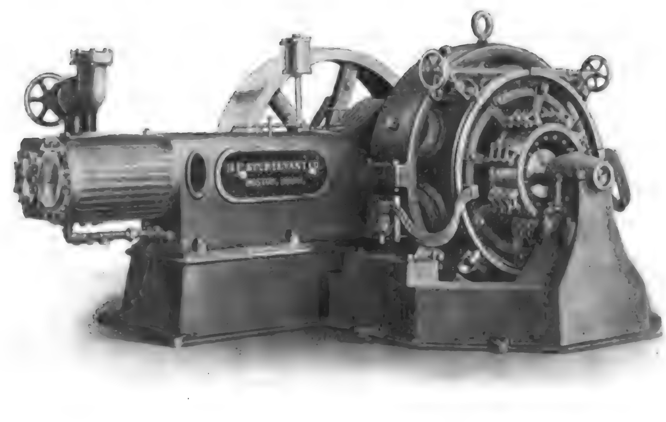


FIG. 1.—STURTEVANT GENERATING SET.

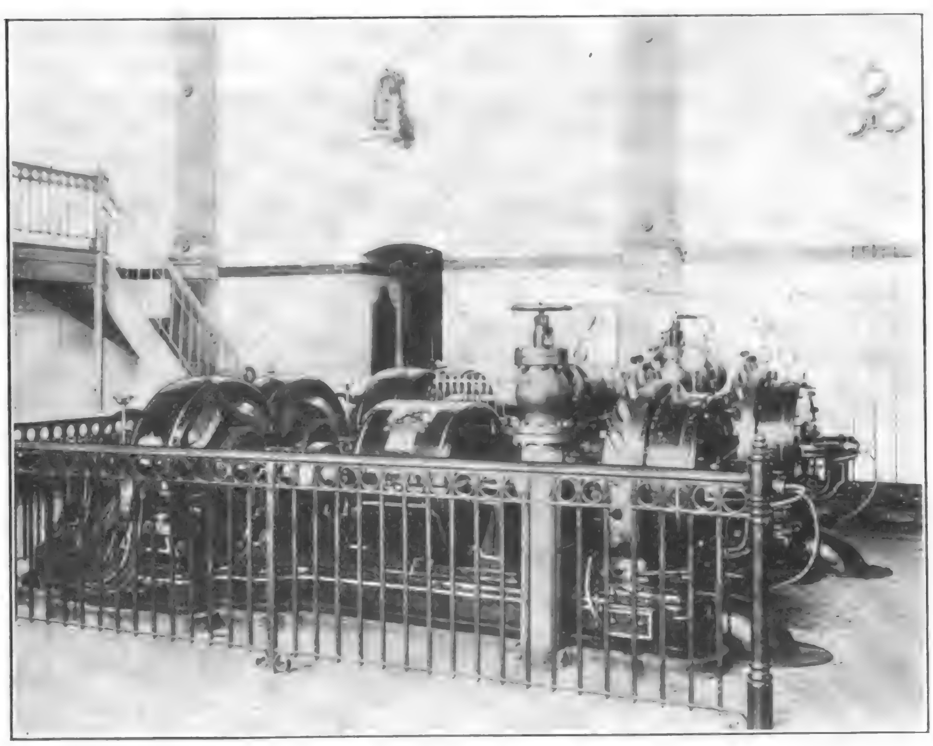


FIG. 2.—TURBO-GENERATOR UNITS IN ANHEUSER-BUSCH BREWERY.

New Apparatus and Appliances

EMERGENCY PIPE CLAMP.

James McCrea & Co., of Chicago, Ill., have brought out the emergency pipe clamp shown by Fig. 1 herewith. The clamp is made of malleable iron complete with packing ready for use. The clamp is easily

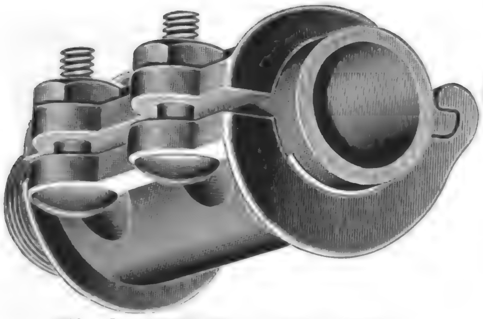


FIG. 1.—EMERGENCY PIPE CLAMP.

and quickly applied, and being compact, is available for pipes which are very close together, such as in coils. The lengths vary from 3¼ ins. to 4 ins., and the size of pipe from ½ in. to 4 ins. For the rapid repair of leaks and splits in pipes, the clamp should find a wide application.

SECONDARY SPARK COILS FOR JUMP SPARK IGNITION.

Fig. 2 herewith shows the "Fire Ball" jump spark coil made by the New York Coil Company, of New York City, which besides being waterproof is claimed to give a fatter and hotter spark with less expenditure of current than others of the same proportions. The coils are said to deliver a full ¾ in. spark with a primary poten-

FIG. 2.—"FIRE BALL" JUMP SPARK COIL.

tial of 6 volts. The contact points are made of platinum-iridium rivets and have large wearing surface. The coils are put up in oak cases and are furnished with or without a vibrator.

HANCOCK VALVES.

Fig. 3 herewith shows a globe valve made by the Hancock Inspirator Company, of New York City, in which many features of merit are combined. The globe, angle and cross valves made by the company are made of special composition, and are screwed and flanged in sizes up to 3 ins. The valves are made one standard only for all pressures. Under test the bodies of the valves are said to withstand a pressure of 4000 lbs., and to remain tight with a water pressure of more than 1000 lbs. per square inch. The discs are made of a special mixture which does not contain any zinc, and the spindles are made of Tobin bronze. From the illustration which shows a 1-inch globe valve, it will be seen that the area of the most contracted part of the valve is ample and of full size. The metal of the valves has been distributed to give uniform strength, and the area has not been reduced for the purpose of reducing the weight. Attention is called to the way the valve is guided on the stem. Two collars upon the stem guide the disc nut and prevent the disc from cocking. The valve seat is flat, and the valve disc has a

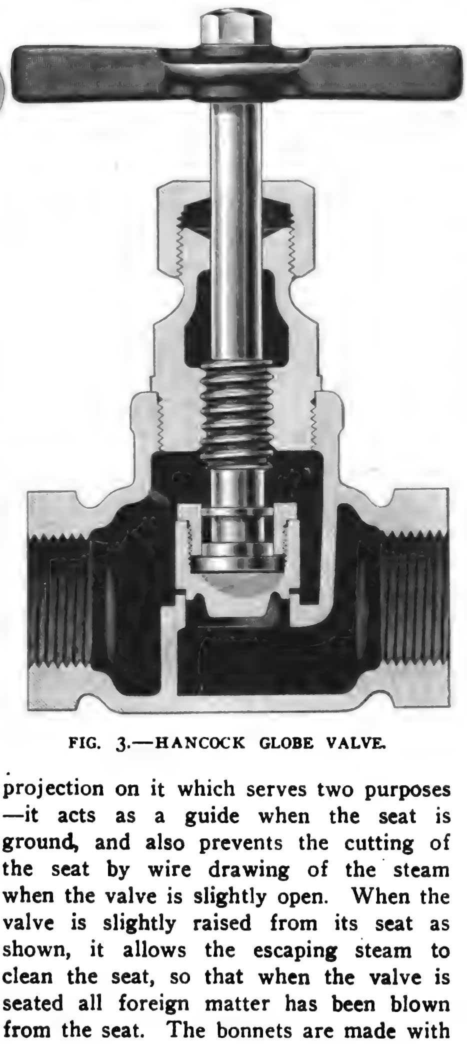


FIG. 3.—HANCOCK GLOBE VALVE.

projection on it which serves two purposes—it acts as a guide when the seat is ground, and also prevents the cutting of the seat by wire drawing of the steam when the valve is slightly open. When the valve is slightly raised from its seat as shown, it allows the escaping steam to clean the seat, so that when the valve is seated all foreign matter has been blown from the seat. The bonnets are made with

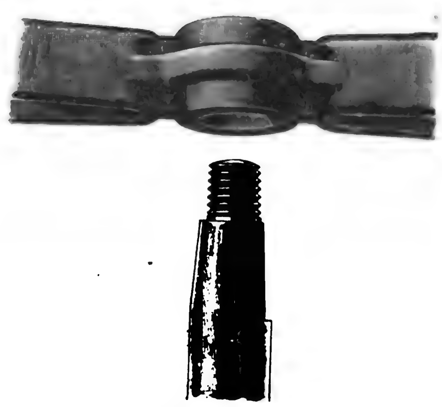


FIG. 4.—HANCOCK TEE HANDLE.

a long thread engaging the body of the valve and the shoulder of the bonnet is made narrow, which is said to be an improvement over the form having a wide shoulder bearing upon the wide surface on the top of the body of the valve. Fig. 4 herewith shows the peculiar method of attaching the tee handle. The hole in the handle is made tapering with one side flat, and the spindle of the valve is also made tapering with one side flat to receive the handle, the tee handle being held on the spindle by means of a nut.

NEW MOTOR CONTROLLER.

The type of controller shown by Figs. 5 and 6, and made by the Cutler-Hammer Manufacturing Company, of Milwaukee, Wis., is intended for the operation of machine tools or similar apparatus, in which the operator is within reach of the controlling handle, the speed regulation being effected entirely by means of shunt field control. The objects sought in design were the provision of a large number of field regulating points, the elimination of possibility of the motor starting on

FIG. 5.—MOTOR CONTROLLER.

weakened field, the operation of the device with a single lever in a simple and natural manner, and the returning of all parts to the starting position automatically under conditions necessitating this action. The apparatus consists of a motor starter of approximately standard construction, and a series of field buttons controlled by a field resistance lever mounted on the same hub post as the starter lever and co-operat-

FIG. 6.—MOTOR CONTROLLER.

ing therewith. In operation the motor is started and brought to speed by moving the handle to the right, this handle being attached to the field regulator lever which is mechanically connected to the starter

lever so as to move them as one piece in starting the motor. During this operation of starting, the field resistance is short-circuited by an auxiliary contact mounted on the starter lever and a curved sector located just below the armature contacts. When the two levers have been moved to the position in which all resistance is cut out of the armature circuit, a keeper on the starter lever is attracted by the retaining magnet, and the starter lever is held in this position. At this time also the auxiliary contact above referred to has left the curved sector thus removing the short-circuit from the field resistance. The field lever is now free for movement over the field rheostat buttons at the will of the operator, and may be left at any desired point, thus regulating the speed of the motor as desired. If the retaining magnet is de-energized either by failure of voltage or by operation of overhead release devices, the starter lever is released and returns to the starting position, carrying with it the field rheostat lever. Fig. 5 shows the "off" position of the controller equipped with underload release, and Fig. 6 shows an operative position of a controller equipped with both underload and overload release.

NEW RECO FLASHER.

After many years of experimenting, the Reynolds Electric Flasher Manufacturing Company, of Chicago, has placed on the market an electric sign flasher for controlling circuits of from ten to one hundred amperes. It is made with one, two, three, four, five, six or more double pole switches having a capacity of 15, 35, 50, 75 or 100 amperes each; thus from fifty to five hundred four-candle-power lamps may be flashed on and off with one switch, and as many switches can be added as desired.

The switches are controlled by cams which close them automatically in any desired sequence or combination. With this flasher,

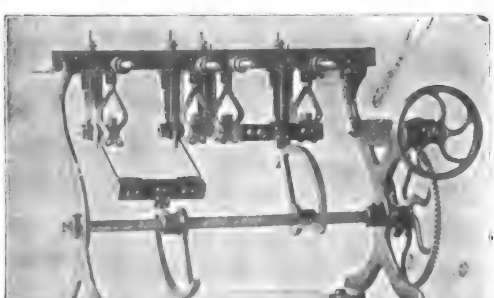


FIG. 7.—RECO FLASHER.

electric signs can be flashed as a whole; double-faced signs flashed alternately, each sign as a whole; or on signs containing a number of words or lines, each word or line can be flashed separately, then all at once. Its mechanical and electrical construction is simpler, it has fewer working parts and is heavier and more substantial than any flasher before produced by this company. Its construction also avoids the multiplicity of circuits running through the flasher, as the division of circuits can be made at a cut-out box located in the circuit between the sign and the flasher. The switch jaws are provided with automatic lubricators in the shape of grease cups or pockets, as shown in the accompanying illustration. These hold sufficient grease to keep the sliding contacts perfectly clean and well lubricated for weeks without refilling. The switch blades drop from the jaws by gravity aided by a spring as they are released by the cams, thus insuring an instantaneous break and avoiding undue arcing. The blades as well as the jaws are made of the best grade of switch copper. Reco flashers are very simple to connect to signs as they are simply cut in between the sign and the service and can be quickly installed to control signs that are already up.

NEW DUNCAN WATT-HOUR METER.

The direct-current watt-hour meter, built by the Duncan Electric Manufacturing Company, of Lafayette, Ind., like other electrical apparatus, has been the subject of marked improvements during the past year.

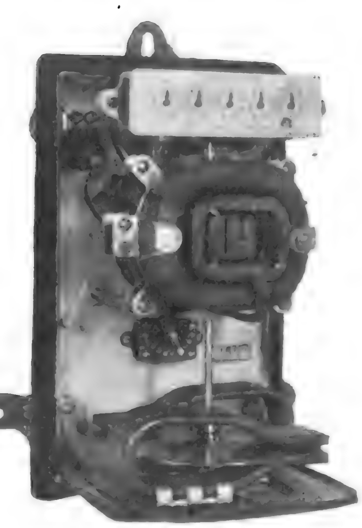


FIG. 8.—DUNCAN WATT-HOUR METER.

Figs. 8 and 8A show the latest form of this meter. The series field coils are machine wound, then thoroughly taped to insure perfect insulation. The manner in which they are clamped to and held on their supporting rods is clearly shown in the illustrations. The armature is wound with 10,000 turns of No. 41 magnet wire and herein lies the meter's superiority to previous direct-current meters; its torque is from 20 to 25 per cent higher while it does not consume as much energy as the older types. The retarding magnets are put through an artificial ageing process requiring six months, and by the time they are put into the meter, they are fully guaranteed not to lose strength, even in the presence of strong external fields. This quality, it is stated, enables the meter to maintain its accuracy indefinitely and prevents any change in its characteristic after being calibrated at the factory. The retarding disc is made from the purest aluminum obtainable and is accurately weighed and balanced before being assembled.

An improvement which undoubtedly appeals to meter engineers and central station managers is the "visual" bearing and "threadless" jewel post of the Duncan meter. The detachable spindle point may be taken out and inserted again without the slightest inconvenience, and without any special tools. The "threadless" jewel post, as the name implies, is without threads; it is held firmly in position by a wire spring, and its insertion or removal requires but a moment. To prevent the brushes from getting out of alignment, they are mounted upon a suitable moulded lava support and, being firmly fastened, their tension upon the commutator is maintained constant, as well as the point of contact. No part in the make-up of a commutator meter is productive of more trouble than the commutator itself. The Duncan Electric Company has made numerous experiments during the past two years in an effort to produce an alloy that would be free from the troubles to which commutators of direct-current motor-meters have been subject ever since their adoption; the result is a composition which is said to be untarnishable, so that the commutator does not turn black after being in service for a short time.

In order to overcome the friction of the bearings and enable the meter to measure accurately very small loads, the compensating coil is rigidly secured within the front series field coil, in close proximity to the armature, and its torque effect upon the armature is adjusted by cutting in or out of circuit a portion of the turns comprising it. The terminals of the various groups of turns of the coil are connected to the contacts of the button switch shown in Fig. 8 just beneath the field coils, by means of which the strength of the compensating winding may be properly adjusted. The advantage of this arrangement over the no pushing in or out of a loose compensating coil, which changes its position every time an attempt is made to fasten it, is obvious.

The binding posts in the Duncan meter are fire-proof, no wood or other combustible material being employed; the mount is of a specially prepared insulating fibre treated with tungstate of sodium. The appearance

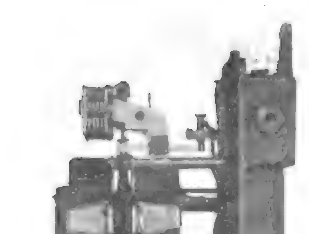


FIG. 8A.—DUNCAN WATT-HOUR METER.

of the meter is particularly pleasing since its finish is that of a semi-dull hard rubber black with the name plate silvered. The dials are unusually large, made of porcelain, and calibrated to read direct in kilowatt hours without the application of any "constant" whatever. The cover is removable

from the front, thereby permitting the meter to be installed quite close to the ceiling. It also fits closely into a felt lined groove and is said to be absolutely dust- and insect-proof. By way of testing the dust-proof qualities of the meter, the makers installed one of them in a flouring mill eleven months ago and upon being inspected three weeks ago, it was found to be as clean and free from dust within, as when first installed.

WESTINGHOUSE OIL CIRCUIT-BREAKERS.

The Westinghouse Electric & Manufacturing Company has brought out a new automatic oil circuit-breaker, known as electrically-operated Type E, adapted to distant control work and designed for voltages from 3300 to 25,000. The circuit-breaker is made in single-pole units, each being mounted apart from the switchboard in a brick or concrete compartment. Two, three and four-pole combinations are made by placing the units side by side. The base of each unit is of treated soapstone and holds two heavy porcelain insulators which carry the stationary contacts and the connection to the external circuit. The movable contacts are at the ends of a U-shaped metal casting fastened at the center to a rod of treated wood, which is moved up and down by the operating mechanism in closing or opening the circuit. The final arc on breaking the circuit is taken by an arcing tip which may easily be replaced. The movable contacts are in the shape of truncated cones and fit into corresponding surfaces in the stationary contacts which are made up of a number of copper springs. This arrangement gives a large area of contact, and is claimed to insure a positive contact over its entire surface, and entirely prevent "freezing" under any condition of overload. The tanks are liberally insulated and the inner surface so shaped as to reduce the amount of oil required, and therefore the fire risk, to a minimum. The open position is in all cases maintained by gravity. A simple system of levers and toggles is mounted on the top of the base and a powerful iron-clad solenoid is arranged with its movable core so attached to the lever system that when the magnet is energized the circuit-breaker will be closed. The standard voltage used on the solenoid is 125 volts. A second electro-magnet acts as a tripping coil and may be controlled by a relay of any desired type. A small single-pole, double-throw switch is mounted on the base and is operated by the motion of the levers in opening or closing this circuit; it controls the tell-tale indicator and lamp which are mounted in view of the operator. The entire mechanism is extremely compact and solid in construction, while the insulation has been carefully provided for. As in other Westinghouse oil circuit-breakers, the break takes place near the surface of the oil instead of at the bottom where there is almost always a certain amount of sediment. These circuit-breakers have no live parts exposed. The oil tanks are firmly held in position by special holders, which, by the simple movement of a lever, may be removed and all contacts examined without disturbing any other part of the circuit-breaker.

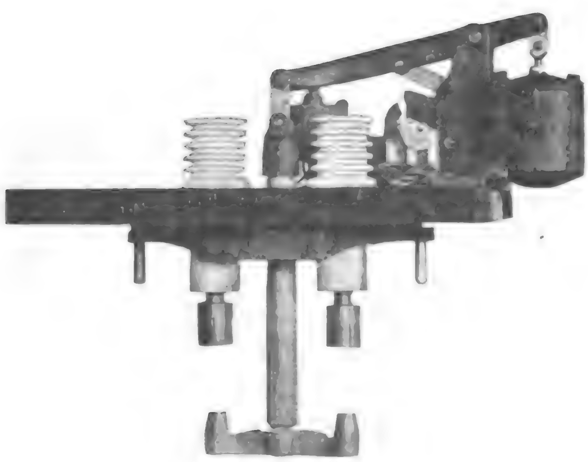


FIG. 9.—WESTINGHOUSE OIL CIRCUIT-BREAKER.

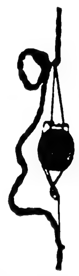


FIG 10.

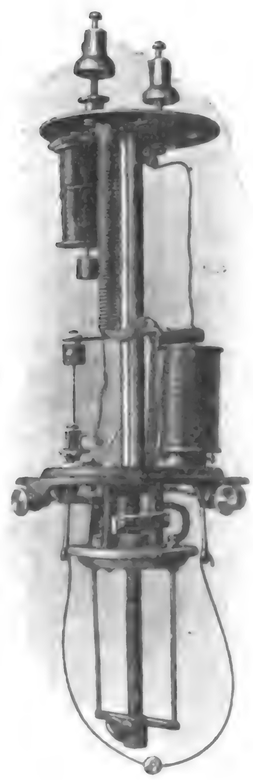


FIG. 11.—WARNER ARC LAMP.

NEW CORD ADJUSTER.

The Marshall Electric Manufacturing Company, of Boston, has brought out the new form of cord adjuster shown by Fig. 10 herewith. The adjuster is intended for use where such adjusters as the Dow are not required. The device does not roll up the cord like the Dow adjuster, but it can be worked by hand, and will doubtless be found satisfactory for many places.

THE WARNER ARC LAMP.

Fig. 11 herewith shows the Warner enclosed arc lamp made by the Warner Arc Lamp Company, of Muncie, Ind. The lamp differs from the usual enclosed arc lamp in that it operates on the shunt principle of control, whereas most arc lamps operate on the differential principle. In the series enclosed arc lamp the carbons are fed in a way which is said to be strictly electrical, the shunt having no connection or control over the series magnet in a mechanical way. For this reason the lamp has but a very small number of parts. There are, the manufacturer says, no springs or multiplicity of rods, levers, dash-pots, pivots etc., nor joints about the lamp to become corroded or stick. The globe cap is made in one piece, and that of an insulating material which is both a non-conductor of heat as well as of electricity so that insulating bushings are not required in supporting the lower carbon holder from the gas cap. The gas cap of the lamp being also an insulator, no additional insulator is required at these points. The gas cap is made large, and is mounted at a suitable distance below the frame of the lamp so as to allow a current of air to go up through the opening at the bottom of the outer globe and circulate around the inner globe, keeping it cool, and over the gas cap between it and the bottom of the lamp, thereby dissipating the heat of the arc and preventing it from entering the lamp body, and raising the resistance of the shunt and series coils. A peculiarity of the lamp is the use of an open bottom outer globe. The lamp is quite light, weighing only 19 pounds with globes complete. The same principle involved in the direct-current series enclosed lamp is also being carried out in the other lamps being brought out by the company. The results are said to be very apparent in the alternating current lamps, the tendency to vibrate and chatter, it is claimed, being obviated. The current in the multiple lamps is said to constantly reduce from the time it picks up until it feeds, often resulting in a variation of from 5 amperes at pick up on 110 volts to one ampere at the time of feeding. The result is said to be a saving in the current consumption, and a slight variation in the amount of light furnished, because as the current is reduced the arc is lengthened and the power lost in the resistance reduces until it reaches a minimum, which the manufacturer claims often falls as low as 20 watts on 110 volts.

NEW BOOKS.

MODERN PRACTICAL ELECTRICITY. By R. Mullineux Walmsley. Chicago: W. T. Keener & Co. Cloth; 4 volumes; 1200 pages, total, 7 ins. x 10 ins.; 1208 illustrations. Price, $12.00.

The title of this rather ambitious work is a misnomer; it might appropriately be entitled a history of the development of electrical apparatus up to 1900, with the equations of fundamental laws and descriptions of interesting antiquities. Very few really modern applications of electricity are described, the first three volumes being devoted to historical matter and descriptions of obsolete apparatus—not merely obsolete to the ordinary degree characteristic of apparatus abandoned a few years ago but so far out date as to be entirely unfamiliar to the present generation of engineers so far as the actual machinery is concerned. It seems a pity that the author should have

so misapplied his technical knowledge, which is evidently not lacking. While the books are extremely interesting and contain a sprinkling of useful information, the latter is such a small proportion of the whole, and therefore so hopelessly buried, that the work has no practical engineering value.

"MECHANICAL WORLD" POCKET DIARY AND YEAR BOOK, FOR 1905. Manchester, Eng.: Emmott & Co., Ltd. Buckram; 333 pages, 4 x 6 ins.; 66 illustrations; numerous tables. Price, 6d.

This is the eighteenth edition of this highly meritorious little reference book, and it shows evidence of careful revision. There have been added tables of the squares, cubes and fourth powers of fractions, trigonometrical ratios, powers and roots of useful factors and sheet and hoop iron gauges. The section on ball bearings has been revised and a table added which gives the relations between ball diameter, number of balls and diameter of ball circle. A short section on the speed and power of small launches has also been added.

FOWLER'S ELECTRICAL ENGINEERS' YEAR BOOK. Manchester, Eng.: Scientific Publishing Company. New York: D. Van Nostrand Company. Boards or leatherette: 600 pages, 3¾ ins. x 6 ins.; 80 illustrations; numerous tables. Price, boards 75c.; leatherette, $1.00.

This is the 1905 edition of Mr. Fowler's well-known pocket book for electrical engineers. It has been carefully revised and somewhat enlarged. Among the new material may be mentioned additions to the sections on parallel operation of dynamos, management of dynamos, types of electrical measuring instruments and their use, electrical distribution, storage batteries and electric traction. The section relating to alternating-current working has been extensively revised and improved. An error on page 156 remains uncorrected; in the formula for maximum allowable number ampere-conductors around the periphery of the armature of a multipolar dynamo, the co-efficient 288 should be 144, in order to make the equation consistent with the one for bipolar machines. We have pointed out this error twice before. The book is excellent, however; it is impracticable to eliminate errors in one of this class.

HUGE ELECTROMAGNETIC CONTROLLERS.

The Electric Controller & Supply Company, Cleveland, Ohio, has just shipped the second of two 200-h.p., 220-volt magnetic-switch controllers to the Lorain plant of the National Tube Company. These controllers are for reversing motors driving the tilting tables on each side of the plate mill. They give automatic acceleration, which can be adjusted to the maximum rate consistent with safety to motor and gearing.

When reversing from full speed forward to full speed reverse, the table is automatically brought to a quick stop and accelerated in reverse direction in the least time interval consistent with safety. The magnetic controller, with its resistance bank is placed near the motor, thereby effecting economy in the use of heavy connecting wire. The operating controller consisting of a small master switch, is conveniently mounted on the roller's "pulpit," and since the contacts of this controller carry only a small current, it may be operated with ease, and the connecting wires are small. The construction of the magnetic controller is such that no matter how rapidly the operating controller may be reversed, the current to the motor is automatically limited to a safe value.

LARGEST GAS-ENGINE-DRIVEN GENERATORS IN THE WORLD.

The California Gas & Electric Corporation, San Francisco, Cal., has just placed an order with Crocker-Wheeler Company for three 4000-h.p. three-phase revolving field alternators, to be driven by 6000-h.p. gas engines to be built by Snow Steam Pump Works. These generators will be the largest in capacity in the world driven by gas engines, and will furnish power to operate the United Railroads of San Francisco, in accordance with a contract recently secured by the California Gas & Electric Corporation. The Snow gas engines, to which they will be direct-connected, are the largest in the world for this class of service. They will run at 83 r.p.m., and the generators will deliver 13,200 volts at 25 cycles. The installation of these three engine-driven generating units in San Francisco will mark an important step for the transmission company, as they will operate in parallel with the water power plants of the company, and thus serve as an important reserve plant for the entire system. One of the units will be used exclusively for handling the peak load on the railway lines.

The securing of this contract by the Crocker-Wheeler Company indicates that the important position this company has held in the direct-current field is also to be maintained in the alternating line.

CUTLER-HAMMER EXPANSION.

The Cutler-Hammer Manufacturing Company, Milwaukee, is building a three-story addition to its factory which will add 50,000 square feet of floor space to the plant. The construction is of the slow-burning type, and it is expected that the addition will be ready for occupancy this month. The building will be equipped with the Grenelle system of sprinklers, will be heated by the Paul system and lighted with mercury vapor lamps. The fire-service storage tank, with a capacity of 75,000 gallons, will be located under the boiler room, and the fire pump will have a capacity of 750 gallons a minute. The power plant for the entire factory will be in the new building, and will be up-to-date in every respect.

As soon as this building is completed work will begin on an addition to the present office building to which another story will be added. The third floor of this building will be entirely devoted to the engineering department, while the superintendent, chief of the engineering department, cost department, publicity department and a part of the accounting department will occupy the second floor. The executive offices and the rest of the accounting department will be on the first floor as at present.

The works of the Cutler-Hammer Manufacturing Company now occupy an entire block, with the exception of a small plot on one corner. Recently this company purchased a plot of ground on St. Paul Avenue, opposite its factory, upon part of which a brass foundry has been erected. Upon the remainder of this property buildings will be erected during the coming year for storage and factory purposes.

THE RECORD RUN OF THE WESTINGHOUSE EXPOSITION TURBINE.

A memorable incident of the morning following the close of the St. Louis Exposition was the formal shut-down and inspection of the 600-h.p. Westinghouse steam turbine generator unit in the Palace of Machinery after a continuous run of over 3962 hours—a performance which has had no parallel in steam turbine work. This machine was started on its long run at 9.20 o'clock on the morning of Monday, June 20, shortly after its installation at the Fair, and was stopped at 11.32 o'clock on the morning of Friday, December 2. During the five and a half months that the unit was in operation it supplied current for light and power throughout the Westinghouse exhibits in the Palaces of Machinery, Electricity and Transportation. Mr. Charles F. Foster, chief operating engineer of the Exposition; Mr. H. M. Holman, supervising engineer at the Government Exposition gas-engine tests, and a number of Westinghouse representatives, including Messrs. Wallace Franklin, of Detroit, C. C. Chappelle, of Chicago, and W. K. Dunlap, managing director of the Westinghouse exhibits, were present when the turbine was stopped. It was found to be in perfect condition, and there were no signs of wear, the bearings still retaining the tool marks as they had come from the shops.

There have been at least two instances on record in America in which reciprocating engines have been run continuously for about the same length of time as that of the record run of the Westinghouse turbine. The remarkable feature of the turbine run, of course, was the maintenance under load of a speed of 3600 revolutions a minute for such a long period. From 8.30 o'clock in the morning to 10.30 o'clock in the evening, every day of the run, the load carried varied from 75 per cent of full load to 25 per cent overload. The total number of revolutions almost touched the billion mark—855,792,000.

THE BUSINESS SITUATION AT THE CLOSE OF 1904

WM. NUGENT & CO., Chicago, Ill.—We have found it necessary to equip our shops with more machinery and engage more men in order to fill our orders.

S. J. STEWART, New Orleans, La.—I have done 50 per cent. more business this year (1904) than last, and the prospects for 1905 seem to be as good if not better.

KNAPP ELECTRIC AND NOVELTY COMPANY, New York City, N. Y.—We find a most satisfactory increase in sales, general conditions good and the outlook for 1905 extremely bright.

THE CRESCENT INSULATED WIRE & CABLE COMPANY, Trenton, N. J.—We are very busy in our Insulated Wire Department, and the prospects for the coming season are very bright.

CROUSE-HINDS COMPANY, Syracuse, N. Y.—Our fiscal year closed July 1, consequently we are not able to say very much at this time. We believe, however, that the outlook for business is fine.

W. S. HILL ELECTRIC COMPANY, New Bedford, Mass.—Our business has never been so good before, and it seems from the general tone as if the present brisk demand for material would continue.

THE FIDELITY ELECTRIC COMPANY, Lancaster, Pa.—We find the prospect for our electrical business for the coming year most favorable. At present we have orders booked to run us three months.

THE DERRY-COLLARD COMPANY, New York City, N. Y.—While the past year has been below par in the book business, there is a decided improvement at present, and prospects for an exceptionally good year for 1905.

AMERICAN DE FOREST WIRELESS TELEGRAPH COMPANY, St. Louis, Mo.—The development of our system during the past year has been very satisfactory, and has exceeded the most optimistic hopes of its friends.

THE KESTER ELECTRIC MANUFACTURING COMPANY, Chicago, Ill.—The closing year has been a very prosperous one for us, business being such as to necessitate running our factory night and day for over three months.

KRAUSHAAR BRASS MANUFACTURING COMPANY, St. Louis, Mo.—The business conditions as we have found them during the past year have been exceedingly good, and present prospects point to a very busy coming year.

ENGBERG'S ELECTRIC AND MECHANICAL WORKS, St. Joseph, Mich.—Our business for 1904 has been by far the best in our experience. We were obliged to take larger quarters because we were unable to keep up with our orders.

LIBERTY MANUFACTURING COMPANY, Pittsburg, Pa.—The volume of business for 1904 was, on the whole, very satisfactory, our business having increased in spite of the general business depression. The outlook for 1905 is very encouraging.

THE VAN DORN-ELLIOTT ELECTRIC COMPANY, Cleveland, O.—We have no complaint to make as to business during the past year. The outlook for next year, however, is considerably brighter than it has been during the past year.

GEORGE W. LORD COMPANY, Philadelphia, Pa.—In spite of the presidential election, 1904 has been the most prosperous in the history of this concern, both domestic and export business showing a marked and very satisfactory increase.

NEW ENGLAND COIL WINDING COMPANY, Atlantic, Mass.—The year 1904 has been the most profitable year of our existence. With the addition of several new winding machines, now in process of construction, we propose to make 1905 eclipse the past year.

THE NEW ERA GAS ENGINE COMPANY, Dayton, Ohio.—Our business has been very good this past year, and prospects for 1905 are very flattering indeed. We were busy during the summer months when some factories were complaining of dullness.

THE FRANKLIN ELECTRIC MANUFACTURING COMPANY, Hartford, Conn.—Our business during the past year has been very satisfactory, and we look for an increased volume during the coming twelve months.

CROCKER-WHEELER COMPANY, Ampere, N. J.—We expect a prosperous season in the coming year. Business appears to be reacting from the depression of the last few months, and more and more purchasers of electric generators and motors are entering the market.

BUCKEYE ENGINE COMPANY, Salem, Ohio.—Our business for 1904 so far (up to December 15) amounts to about 70 per cent of that for 1903. We have operated our plant with a full day force and on full time. Prospects for the coming year are for an increased business.

BROWN CORLISS ENGINE COMPANY, Corliss, Wis.—Business has improved very materially in the past sixty days. We now have on our books over $190,000 worth of work, and have a great many quotations outstanding on work which promises to come our way.

ELECTRIC MACHINERY COMPANY, Minneapolis, Minn.—The last twelve months have been quiet as compared with a few years previous, but the outlook for the coming year seems better, and business will, we believe, show marked improvement over the year that has just closed.

FLEMING SLATE COMPANY, Erie, Pa.—Things look very bright in the electrical line, and already good orders are coming in. This company has moved its general offices from Poultney, Vt., to Erie, Pa., where all communications should be addressed. Mill and quarries at Poultney, Vt.

E. D. DRAKE & CO., New York City, N. Y.—We have no fault to find with trade conditions, and the outlook is good. The conduit manufacturers are in the midst of a silly war of prices that benefits no one and injures us all, but common sense will soon prevail again and our business promises well.

AMERICAN BRAKE SHOE & FOUNDRY COMPANY, Chicago Ill.—Since the election our orders show a decided improvement in several lines, although they have been a little light previous to this. We are turning out a very satisfactory tonnage of low carbon steel castings for motor and dynamo work.

AMERICAN ENGINE COMPANY, Bound Brook, N. J.—Our experience and observation has been that 1904 has been been a poor year, but since the first of October there has been a marked improvement in the amount of business offered, and we think the prospect is extremely encouraging for next year.

MUTUAL ELECTRIC & MACHINE COMPANY, Wheeling, W. Va.—We have found that business has greatly improved in the last three months, and the demand for our product seems to be increasing very materially, especially throughout the East and on the Pacific Coast. Business in the main is very satisfactory.

THE GREEN FUEL ECONOMIZER COMPANY, Matteawan, N. Y.—Although we have not done as much business in the past year as we did in 1903, our business in the electrical field was satisfactory, and from the inquiries received and work that we have on, our business in that field for 1905 looks very promising.

THE CHICAGO RAWHIDE MANUFACTURING COMPANY, Chicago, Ill.—The past year has been the largest and best we have ever experienced. We find the demand for goods in our line of manufacture is steadily increasing, and feel confident that the coming year will be at least as prosperous as 1904 has been.

MILTON F. WILLIAMS MANUFACTURING COMPANY, St. Louis, Mo.—Our business in the past year has been very good, and the future looks exceedingly bright. We do not manufacture electrical machinery, and are not particularly interested in electrical appliances; we refer entirely to the crusher business.

WARNER ARC LAMP COMPANY, Muncie, Ind.—Trade has been exceedingly good during 1904, orders coming in almost every day from all points of the compass for Warner lamps. We are expecting the next twelve months to be even better than the year just passed; at least, the outlook seems to warrant this conclusion.

MOLINE INCANDESCENT LAMP COMPANY, Moline, Ill.—Our business is increasing at a very rapid rate. October business was 106 per cent. over the previous month; November, 90 per cent. over October, December starting in to show an increase over November of possibly over 60 per cent. The outlook for business with us is good.

THE CUTTER ELECTRICAL AND MANUFACTURING COMPANY, Philadelphia, Pa.—While our business has not been as good as it was in 1903, the volume

has been entirely satisfactory. The outlook for the future was never better. We are just about increasing our factory space 50 per cent., and we fully expect to have use for all of it.

THE MERIAM-ABBOTT COMPANY, Cleveland, Ohio.—Our business prospects are such that we are preparing to increase our output and also to build much larger engines. There is a very promising outlook in the field of direct-connected generating sets, and we are putting in a number of plants for lighting office buildings and private residences.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa.—Sales during 1904 of the batteries manufactured by us have been satisfactory. New applications of batteries are constantly developing, and their use in what may be termed the standard applications is growing. We consider the prospects for the coming year excellent.

GREEN ENGINEERING COMPANY, Chicago, Ill.—In our opinion the business situation is in better shape now than it has been for a long time, and we anticipate doing a larger business in 1905 than during the preceding year. We are very well satisfied with the past year's business, and especially so since the election, having closed twelve contracts since that time.

THE STERLING ELECTRICAL MANUFACTURING COMPANY, Warren, Ohio.—We have found business in the main during 1904 fully as voluminous as in 1903, but without any noticeable increase. From all appearances the year 1905 will be a bumper, and we look for from 25 to 30 per cent. general increase in the demand for incandescent lamps over the past year.

THE FOOS GAS ENGINE COMPANY, Springfield, Ohio.—Business with us is heavy and prospects never better. We have during the last year considerably increased our facilities, but the plant is still taxed to the utmost. Our agents without exception advise us that we will have to work harder than ever before to keep up with their demands during the coming year.

THE ROBBINS & MYERS COMPANY, Springfield, Ohio.—The business of our last fiscal year, which closed September 30, was the best in the history of our company. While it is difficult to predict for the future, we are inclined to think that business will be found to continue on a healthy basis; as for ourselves, we are looking forward to a better year than last.

CLEVELAND ARMATURE WORKS, Cleveland, Ohio.—The last year's business has been the largest in our history, and we are making preparations for handling a greater volume next year, and see no reason why we should be disappointed in our expectations, but our business being that of electrical repairs, is not a particularly good one from which to judge the pulse of trade.

THE C. & G. COOPER COMPANY, Mt. Vernon, Ohio.—We have had a large amount of business during the past year. We have just completed an extensive addition to our new machine shop, which is in full operation. Large orders for Corliss engines have been received in recent months, so that we are now working day and night to meet the demands of our increasing trade.

A. ROE & CO., New York City, N. Y.—Our specialty is the design and construction of power plants and lighting systems, in which we have been very busy, principally on preliminary work, there having been of late much difficulty in financing enterprises of this nature, except in the large cities. At present there are good indications of a busy spring along all lines of construction.

KEYSTONE LUBRICATING COMPANY, Philadelphia, Pa.—We have been doing an increasing business, month by month, during the whole year, and every month in this year has exceeded from 25 to 50 per cent. the corresponding month of 1903. Our business is still increasing, and for 1905, if business comes in as it promises now, we expect to do twice the business that we have done in 1904.

STANDARD UNDERGROUND CABLE COMPANY, Pittsburg, Pa.—We found the business conditions surprisingly good in our lines during 1904, considering the fact that it was a presidential election year. Business has increased very materially during the last month, and we consider that the future prospects of our own and the electric business generally are very good indeed.

RIDGEWAY DYNAMO & ENGINE COMPANY, Ridgeway, Pa.—We had a good year's business, with our factory running full time, but have found during the last month or six weeks a less active market. We look for a prosperous year for 1905 but hardly expect that buyers will be placing their orders till the spring is well advanced and the weather will permit construction to begin.

FARR TELEPHONE & CONSTRUCTION SUPPLY CO., INC., Chicago, Ill.—The telephone business for the year 1904 was about up to the standard of previous years for the first six months of the year; after that there seemed to be a steady decline in trade up to election time. We notice a marked improvement in our business since election, and indications are pointing to a very heavy business for 1905.

AMERICAN WATER SOFTENER COMPANY, Philadelphia, Pa. — Although business conditions as we have found them during the past year, have been somewhat dull, we have been able to do a constantly increasing business. Since September 1 trade seems to have improved considerably, and present appearances are that we will have an increase of business with the first of the year that will tax our abilities.

THE R. M. CORNWELL COMPANY, Syracuse, N. Y.—During the past year our business has increased over 100 per cent. The automobile business, which we took on about one year ago, has turned out very much better than we expected. We sold over 100 machines in all. Our dynamo and motor sales for the past year have been more than doubled. In our supply department, business has never been better.

ELECTRICAL APPLIANCE COMPANY, Chicago, Ill.—The year just closing has been a disappointment to us in the volume of business and net results, and we believe this condition has been quite general in the electrical trade, and more or less general in other lines. However, we consider the outlook for 1905 to be very favorable, and are looking forward hopefully for a material improvement in business conditions.

THE PHILADELPHIA ELECTRICAL AND MANUFACTURING COMPANY, Philadelphia, Pa.—With the exception of the months of June and July of 1904, we have been extremely busy. For some time we have been as much as three months behind orders for certain goods, and from the business and inquiries that we are receiving we have every reason to believe the outlook for the future to be exceedingly good.

THE LAGONDA MANUFACTURING COMPANY, Springfield, Ohio.—The past year has been a very busy and successful one with us, and our trade has steadily grown, although along in latter part of September and October, it seemed a little dull. Since then, business seems to have taken somewhat of a boom, and we have been busier than ever before in our history. As far as we can determine, the outlook is very favorable.

HENRY H. HUMPHREY, St. Louis, Mo.—Business is very good at present, and the prospects for the new year are most encouraging. During the last year, particularly while the World's Fair was in progress, business has been exceptionally quiet in building and engineering work, as far as my experience and observation have gone With the closing of the successful Exposition and the outcome of the election, the outlook is very much brighter.

D. M. STEWARD MANUFACTURING COMPANY, Chattanooga, Tenn.—Our business in 1904 shows considerable increase over 1903. The business of September, October and November, 1904, was almost double that of the same months last year. We now have more unfilled orders on file than ever before at the same time of the year. We believe that 1905 will be a splendid year for electrical business, and are preparing to take care of an increased trade.

ELECTRICAL TESTING LABORATORIES, New York City, N. Y.—Our business has increased noticeably since the election, and our prospects for a continuance of the present rate of increase seem good. Our business was much better during the months of August and September than during October. Whether the slump preceding election was due to that cause or not we cannot say, but the improvement immediately after election was marked and still continues.

THE HOLTZER-CABOT ELECTRIC COMPANY, Brookline, Mass.—Although we have continued to run full time and with practically a full force throughout the past year, yet we have felt to some extent the general lull in business. November has

shown quite a marked increase in inquiries and orders, and the indications point to a general revival of business. We will be very much surprised if the coming year does not prove to be a very busy one in the electrical industry.

DE LAVAL STEAM TURBINE COMPANY, Trenton, N. J.—We found business conditions during the past year very fair, and since September have noted a decided improvement, and consider the outlook in our line encouraging.. It might be of interest to note that since the latter part of 1901, when we commenced work, we have built 297 steam turbines, 146 of which are driving electrical apparatus, 95 driving centrifugal pumps, 32 driving fans, and 24 other purposes.

MARSHALL ELECTRIC MANUFACTURING COMPANY, Boston, Mass.—Our business for the past year has been fully up to the average, and during the autumn months there was a decided increase over any previous year since we have been in business. Inquiries, too, are more numerous than for a long time, which indicates that people using our goods are contemplating still further activity in the near future; we, therefore, look for an exceptionally good business during the coming year.

PENBERTHY INJECTOR COMPANY, Detroit, Mich.—Although business conditions have been somewhat unfavorable during the past year, we have noticed a marked improvement in business during the past sixty days, and in our judgment the coming year should be one of exceeding prosperity. We cannot speak with any knowledge concerning the electrical business, as we do not come into close touch with that line, but as regards the steam supply trade, we believe 1905 will be a banner year.

CHASE - SHAWMUT COMPANY, Newburyport, Mass.—We have found the electrical manufacturing business during the past year very poor up to the latter part of September. However, within the last two or three months a marked improvement has been noticeable, certainly in our lines. We think that the business of the coming year will, without doubt, be the largest that has ever been seen in this line, due largely to the fact that the improvements on our goods have been rapid and quite marked.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio.—Business during the past year has not been equal to what it was for three or four years back. However, during November business picked up with us materially; in fact, we did more than in any two previous months during the year. This was also true of December. The outlook for the coming year is quite promising. Judging from present reliable indications, we believe that after the early spring we will all have about as much as we can attend to.

HAPGOODS, New York City, N. Y.—The year just closed was one of unusual prosperity. The number of our offices has been increased to a total of twelve, thoroughly covering the entire country. Favorable conditions in all lines of business have created an unusual demand for men; inquiries from electrical companies have been particularly numerous, and men have been supplied for positions in the executive, advertising, accounting and other departments, as well as in the drafting and engineering branches.

I. P. FRINK, New York City, N. Y.—During the past year our trade has held steady in the electrical jobbing centres, and where store improvements, according to trade reports, have been greatest. We are of the opinion that the coming year is going to disappoint those who are not prepared to handle more business. The reports which we have of buildings in progress and contracts let for operations to be started in the spring satisfy us that there will be many opportunities for manufacturers to sell high grade equipment.

THE TETER-HEANY DEVELOPING COMPANY, York, Pa.—We began business on June 1, 1904, at which time we found business very dull. It continued to be so during the greater part of the summer, but about the middle of September began to brighten up, and it has been improving ever since. After October 1 we were rushed with orders, and business has been increasing rapidly within the last month. We feel so sure that it will keep on doing so, that we may move into larger quarters this spring.

JAMES L. ROBERTSON & SONS, New York City, N. Y.—We have had a fair amount of business during 1904—not near so much as in either of the previous two years, but enough to warrant us in believing we have had our share. We are not with those concerns who report a noticeable improvement since the election, but we feel sure there is before us (for at least four years) a *good, healthy* condition of business, and so strong are we in that belief we will "mortgage the farm" if necessary to secure a good-sized share.

STURGESS GOVERNOR ENGINEERING COMPANY, Watervliet, N. Y.—We have found business extremely satisfactory in the past twelve months. The greater part of the year we have been obliged to work day and night shifts, but lately, owing to an addition of about 60 per cent. to our building, we have been enabled to get along with the day force which numbers the same as the day and night forces did formerly. We have more than doubled our business in the past year, and prospects are very bright for the future.

MARINETTE GAS ENGINE COMPANY, Chicago Heights, Ill.—Since the recent election we are experiencing a large and active increase in not only orders but substantial inquiries from all parts of this country, and many foreign countries, particularly for gas engines to be installed in connection with electric lighting plants. We have booked orders during the past two weeks, which, in volume of business, aggregate more than we have received in the preceding three or four months and from present indications we anticipate a very active and prosperous year.

FITCHBURG STEAM ENGINE COMPANY, Fitchburg, Mass.—We have had all the work we could do for the past year, although it has taken harder work to get orders than it did the previous year. We have now two or three months' work ahead, and inquiry is very much larger than it was three months ago. The prospect of the engine and electrical business we think is first-class for the coming years. We are fortunate, however, in that there has been no time during the last twenty years when we have not been running full time, and usually with a good deal of work ahead.

THE VOUGHT-BERGER COMPANY, La Crosse, Wis.—We have no complaint to make relative to our business during the year 1904. The appearance of rust on the crops in Northwestern Minnesota and the Dakotas interfered with the building of farm lines in that territory, but in spite of this, trade conditions in the Northwest during 1904 were better than the year previous. The telephone business in the South and in the far West is showing splendid advances. The first ten days of December brought us heavier business than any previous period at this time of the year.

SMITH & HEMENWAY COMPANY, New York City, N. Y.—In view of the large improvements going on in the electrical world and the many inquiries that we are receiving for electrical tools, we think that 1905 will be one of our banner years. We have noticed a perceptible improvement in the quality of goods ordered by the electrical construction companies. Formerly, it was a question of price with them; anything that would do the work. To-day they look into the merit of an article very thoroughly before purchasing. We are looking for a big business, and are preparing to take care of it.

JOS. E. LOCKWOOD, Detroit, Mich.—As my present business as sales agent of the Bullock Electric Manufacturing Company, Allis-Chalmers Company and the Electric Storage Battery Company, began about May 1, 1904, I am not, of course, in position to judge of the normal demands in the lines I represent during the first year, but I have found a fair demand existing in the three lines I represent from the beginning. During the last sixty days, however, inquiries and actual orders have increased steadily, and the amount of desirable business now in sight is much greater than at any previous time during this year.

THE AUTOMATIC ELECTRIC COMPANY, Chicago, Ill.—We have enjoyed a most prosperous and satisfactory year. We have equipped within the past twelve months nearly fifty exchanges with automatic telephone equipment, and have built and installed additional apparatus for large exchanges, which were put in service in 1903, and we have completed and put in service exchanges which were begun late in

1903. We have had a splendid year, and are looking forward to a still better one. For 1905 we have about a million dollars' worth of orders on hand. We are running our plant full capacity, and are working overtime on pending orders.

THE BANNER ELECTRIC COMPANY, Youngstown, Ohio.—The volume of business done in each month of the past year has shown a very satisfactory increase over the corresponding month of the previous year, and up to this time the average percentage of increase in the volume of business transacted this year, as compared with last year, is approximately 37 per cent.; this applies to actual shipments. Business in almost every line has shown marked improvement within the last two months, and we believe that we are just entering upon an era of unprecedented good times, and the electrical business generally will certainly participate largely in the general prosperity.

THE PLATT IRON WORKS COMPANY, Dayton, Ohio.—This company had on January 1, 1904, sufficient orders to insure the operation of its entire force and equipment for the ensuing four to five months, consequently the alleged diminution in volume of trade was not in evidence until the months of June and July. We have had a diminished trade because the erection of contemplated power plants has been deferred, but we approach the new year with abundant confidence, basing our conviction upon the fact that there has been a marked increase in trade during the past sixty days, although a decrease in orders is always encountered during the fall and winter.

H. W. JOHNS-MANVILLE COMPANY, New York City, N. Y.—Our electrical business has never known a year of such prosperity as 1904. The amount of material turned out from our factories has been far greater than in any previous year, and our entire product has been advantageously placed. The outlook for the coming year in this country, particularly in railway work, bears greater promise of activity than any year within the past decade. Our British and European business also gives us much cause for self-congratulation. Our factories, although improvements and additions have been made constantly, are running at their utmost capacity to handle our orders.

HARRISBURG FOUNDRY & MACHINE WORKS, Harrisburg, Pa.—This company has been exceedingly fortunate, having been able to operate its entire plant day and night without interruption now for five years. Our gross business for 1904 was only 7 per cent. lower than that of the high-water mark years of 1902 and 1903, and prices have been fairly satisfactory. Looking forward to 1905, we find while inquiries for delivery into the next year are numerous, there is a disposition to hold off until business results are determined and prices finally adopted for the future. We can see, however, no reason for not expecting a very large business during the coming year.

CONSOLIDATED ENGINE-STOP COMPANY, New York, N. Y.—Business conditions with us during the past year have not been particularly satisfactory, but as to the future prospects we are extremely optimistic. Soon after election orders and inquiries began to increase, and we have had the largest month so far (up to December 20) that we have had since April, 1904, and we expect a large business in 1905. In addition to the increased number of orders, the most gratifying improvement we have experienced is the increased number of inquiries regarding engine stops from large manufacturers and power companies. We mention this, for heretofore it has been somewhat difficult to interest them in automatic engine stops.

SHEPHERD ENGINEERING COMPANY, Franklin, Pa.—Business during the past year was generally very dull, although there were occasional spurts of activity at various times. This company received a great many inquiries, and on the whole did a very fair business. But the number of inquiries received was out of all proportion to the actual business closed. For some reason or other the majority of prospective purchasers wanted to put off buying until about or after the first of the year. There has been a wonderful improvement, however, during the past six weeks, and more actual business has been booked in this time than there was in any preceding three months of the year. The prospects for 1905 are all that one could desire.

THE LANE & BODLEY COMPANY, Cincinnati, Ohio.—Our experience during the past year (1904) has shown the demand for engines to have improved over the preceding year. This is especially true of the latter half of 1903. A conservatism among buyers has been noticeable throughout 1904. The engines sold seemed to be required more for the extension of established businesses than for new enterprises, which indicates to us a healthful foundation for the future. There seemed to be at no time during the year a disposition to speculate on the future of business, but to fill requirements actually developed. We are quite optimistic in connection with prospects for the year 1905, believing the atmosphere is cleared and there is nothing to prevent the progress and expansion naturally ahead of us.

WILLIAM D. MARKS, Philadelphia, Pa.—During the past year the market for electric railway and light station securities has been open only to the very highest class of going and proved properties, and consequently there have been very few large new enterprises placed in the hands of engineers for construction; on the other hand, many going enterprises have made extensions, and are still making them. For six months the manufacturers of general machinery have had slack shops, and even since the election there has been no sudden and broad revival of business such as has been generally expected. This condition, it appears to me, will not continue, and when constructed becomes possible next spring, I believe there will be many carefully studied enterprises launched, the success of which may be predicted from our experience in the past.

BATES & NEILSON, New York City, N. Y.—Business conditions during the past year have been, comparatively speaking, quite dull. There is, however, a decidedly better tone to the general market at present, and it is to be expected that after the first of the year there will be increased activity. This year's depression in business will have its good effect. Those who successfully weathered the storm are better for their experience to-day, and those who did not pull through were not equal to the task they had undertaken. To-day the conditions are excellent for the upbuilding of business of good, substantial character. For the past three months it has been clear that this state of affairs has been apparent to many, with the result that steel works, manufacturing establishments and contractors throughout the country are taking on men to fill the places of those whom it was necessary to let go last January and February.

AMERICAN AND BRITISH MANUFACTURING COMPANY, Providence, R. I.—Business in general for 1904 has been quiet in all departments. The Corliss Works, at Providence, have shared the exceptional stagnation in steam engine demand due to the general dullness and the waiting attitude of power users to see where the turbine comes in. This combination has produced, perhaps, a record breaker for dullness, but steam engine inquiries have begun to come in freely, and the promise for 1905 is bright. It looks like the beginning of another prosperous period, equaling that recently past. The Diesel engine department has been steadily gaining through 1904. The prospect is for a rapid increase through 1905, with all the demand we can supply before the year ends. Our condenser department is well established, and has a very bright prospect for 1905.

DODGE & DAY, Nicetown, Philadelphia, Pa.—We have had a very prosperous year, regardless of the period of depression which prevailed along some lines prior to the presidential election. Our relations in an engineering capacity with various manufacturers gives us a clear insight into their business, past and prospective, owing to the character of our work, so that it is with some degree of certainty that we say that prospects for the coming year are exceptionally bright. We have been called upon to make a number of layouts contemplating the expenditure of several millions of dollars, which is the best indication we know of that manufacturers are sanguine as to future business conditions. We also know that the inquiries being received by our clients for quotations on their apparatus are larger at the present time than they have had for months past, and the feeling all along the line seems to be confidently optimistic.

THE LOMBARD GOVERNOR COMPANY, Boston, Mass.—We found busi-

ness conditions during the past year remarkably good. At the beginning of the year we were inclined to think that business might be slack, as the general business conditions at that time were not favorable, but our great difficulty last year was to keep up with our orders. This condition of things has continued steadily, so that we are about to move into a new factory, having about three times the floor space of our present factory. It is always difficult to predict what the condition of business will be for any very great length of time ahead. There is no doubt that general business is in an extremely satisfactory condition at the present time. There are a number of very large projects which will undoubtedly be satisfactorily financed within the next few months. In a general way we anticipate that those who are engaged in building and equipping water-power plants will have a very busy year of it.

AMERICAN ELECTRIC FUSE COMPANY, Chicago, Ill.—During the year 1904 the volume of our business was slightly less than during 1903. The falling off in orders was most noticeable during the months from July 1 to November 1. Since the election the increase in our orders has been very large, indicating that there was a considerable element of suspense entering into the question of business. In the independent telephone field the question of financing the projects made necessary by the public demands for telephones has probably had considerable to do with the comparative shortage in the manufacturing business. In our opinion, the entire question of the future of the manufacturing business in the independent telephone field is purely a question of the ability to secure the necessary capital with which to make necessary developments. The manufacturing outlook for the coming year is encouraging. Advance inquiries indicate that the comparative inactivity of 1904 has resulted in a very large and pressing demand for new material in 1905.

ELECTRICAL EQUIPMENT & SUPPLY COMPANY, Pittsburg, Pa.—In spite of the fact that 1904 was generally considered a panic year, and general business reports have been somewhat unsatisfactory, our experience has been quite to the contrary. Business has steadily increased, and we find it now in a very satisfactory condition, our business in November having shown an increase of 33 1-3 per cent. over the previous month. This is by no means an exception, as in several instances this year we have experienced an increase of 50 per cent. As to future prospects, we feel much encouraged, as everything seems to point to a very satisfactory season. The feature of the indications for the future which seems most satisfactory is the conservative manner in which people are going ahead with work, and not attempting to do everything at once. After every Presidential election, there is a renewed activity which lasts for awhile and then tapers off. In this case, however, the outlook seems to be very stable, as many of the projects which are being undertaken in our territory seem to be of the most conservative and enduring nature.

ABNER DOBLE COMPANY, San Francisco, Cal.—Our business in the water-wheel line during 1904 has been very satisfactory, the volume being greater than we anticipated at the beginning of the year. The business has shown a substantial increase over the previous year, and the outlook for the coming twelve months is very encouraging. Our present works have been overtaxed, and in order to provide facilities for our growing business, we have purchased a three-acre site with railroad connections near the commercial center of San Francisco, where we plan to erect a most modern plant equipped with the latest tools and appliances for the manufacture and testing of everything in the hydraulic line. An interesting feature of the past year's business on the Pacific Coast is the increase in size of hydro-electric units installed in water power plants. During the year the De Sabla power house has been completed, in which are installed two 3700-h.p. and one 8000-h.p. Doble water-wheel units, operating under a head of 1561 feet. The 8000-h.p. water-wheel is the largest single runner unit ever built. We are now constructing three 8000-h.p. water-wheels for the Electra plant of the Standard Electric Company.

NATIONAL ELECTRIC SIGNALING COMPANY, Washington, D. C.—Commercial progress in wireless telegraphy has been almost completely blocked by Government interference during the past year, so far as American companies are concerned. The three openings for wireless telegraphy are to supplant cables, to communicate between ships and shore, and to work over land in the place of wire lines. The first opening has been shut off by the action of the British Government in declining to permit our company to erect stations on British territory. The second opening was blocked by the action of the Joint Wireless Board, recommending that the Government erect stations and handle all messages from ships free of charge, and that no commercial companies be allowed to communicate with ships at sea. The third opening is at the present time a small one, because it is necessary that the multiplex system should be thoroughly developed before wireless telegraphy can enter into competition with the Western Union and Postal Telegraph Companies. So far as the United States is concerned, the year closes with very bright prospects. In some experiments conducted by the United States Navy Wireless Board in August and September of this year this company showed that a station could receive messages without interference while another station only a few hundred yards away was sending at full power. All reason, therefore for Government monopoly has been removed, and it is understood that the United States Government now proposes to make no restrictions on the operation of any bona fide wireless company, other than registration, and does not propose to compete in any way with commercial wireless companies.

OBITUARY.

W. FORMAN COLLINS, for several years connected with the *Western Electrician*, Chicago, died suddenly on December 21. Up to the time of going to press, we have been unable to obtain any particulars.

PERSONAL.

MR. RALPH D. MERSHON, the well-known consulting engineer, has removed his offices from 29 Broadway to 11 Pine Street, New York.

MR. C. C. LEWIS, for the past two years chief engineer of the Schenectady Railway Company, has severed his connection there to join the staff of J. G. White & Co., Ltd., London, England.

PROF. HARRY E. CLIFFORD, Acting Chief of the Department of Electrical Engineering at the Massachusetts Institute of Technology, has been appointed professor of theoretical electricity.

DR. LOUIS DUNCAN, who is well known throughout electrical engineering circles, has been retained by the Allis-Chalmers Co. as an expert in electrical patent work in connection with the Bullock department of the company.

MR. J. H. PERKINS, general superintendent of the Youngstown Consolidated Gas & Electric Company, has resigned that position and accepted the general management of the Wilkesbarre (Pa.) Gas & Electric Company, taking effect January 1.

MR. H. H. SINCLAIR, vice-president of the Edison Electric Company, Los Angeles, Cal., has returned from an eight months' trip to the Sandwich Islands, the Philippines, Japan and other Asiatic countries and resumed his work in Los Angeles.

MR. JOHN McC. PRICE, the well-known and popular salesman of the Electric Equipment & Supply Company, Pittsburg, Pa., has been promoted to the position of general sales manager and now has under his direction the company's entire traveling force.

MR. J. U. JONES, of Dallas, Tex., one of the best-known salesmen in the Southwest, has joined the staff of the Allis-Chalmers Co., of Milwaukee, and will hereafter represent the company in the sale of all of its products in Texas and its tributary territory.

MR. J. B. McCLARY, formerly manager of the Railway Department of the Birmingham (Ala.) Railway, Light & Power Company, has been appointed general manager of the Sheffield Company, his responsibilities including the public utilities of Florence, Sheffield and Tuscumbia.

MR. JOHN CRAIG HAMMOND, Denver, has been appointed chairman of the local publicity committee for the next convention of the National Electric Light Association which is to be held in Denver. The association is to be congratulated in securing Mr. Hammond's services in this capacity.

MR. C. W. WHITNEY, who for some time past has been connected with the McGraw Publishing Company as traveling editor for all of its periodicals, has joined the staff of the Abner Doble Co., San Francisco, builders of the Doble tangential water wheels and designers of electric power and hydraulic plants.

MR. BENJAMIN F. PEARSON, formerly superintendent of power for the Edison Electric Company, Los Angeles, Cal., has been promoted to the position of general superintendent, in which position he will have entire charge of all new electrical construction, as well as the supervision and operation of all of the Edison Co.'s plants.

MR. CHARLES H. TUCKER, recently the assistant chief engineer of Pawling & Harnischfeger, Milwaukee, has been appointed chief engineer of the Case Manufacturing Company, Ohio, designers and builders of cranes and special machinery. Mr. Tucker has an enviable reputation as an engineering expert on crane design and construction.

MR. O. A. STRANAHAN, for the past three or four years in charge of the engine business of the British Westinghouse Company, has been appointed manager of the Power Department of the Allis-Chalmers Co. and will have charge of the

sales of steam engines and turbines and gas engines. Mr. Stranahan's headquarters will be at Milwaukee.

MR. CAMPBELL SCOTT, the well-known secretary and general manager of the C. & C. Electric Company, has resigned that position, taking effect January 1. Mr. Scott has been chiefly responsible for the prominent position in the electrical manufacturing field which his company has attained during his management, and his loss will undoubtedly be much regretted by the other officers of the company. Mr. Scott's plans for the future are not yet sufficiently crystallized to permit any definite announcement of them.

Mr. W. J. SANDO, who has had a wide engineering experience in the field of pumping machinery, has been appointed manager of the Allis-Chalmers pumping machinery department, with headquarters in Milwaukee. Mr. Sando served as chief engineer to the New York City Commission on Additional Water Supply from May 1, 1903, to January 1, 1904, prior to which service he was connected successively with the International Steam Pump Company and E. D. Deavitt, the well-known designer of pumping machinery.

MR. S. M. KEEBLE, who has for many years been associated with the Frank Adam Electric Company, of St. Louis, and under whose management that company's switchboard business has developed into one of the most important of its kind in the West, has resigned his position there to become general sales manager of the Cutter Electrical & Manufacturing Company, with headquarters in Philadelphia. Mr. Keeble's familiarity with the circuit-breaker and instrument business, resulting from his long experience, should make his services of great value in his new position.

TRADE PUBLICATIONS.

MICA. Eugene Munsell & Co., New York and Chicago.—A pocket-size catalogue of India and amber mica, cut and uncut, for electrical work.

ROTARY CONVERTERS. The Bullock Electric Manufacturing Company, Cincinnati, Ohio.—This is Bulletin No. 1031, containing an illustrated description of the Bullock rotary converter.

WINDOW LIGHTING. H. T. Paiste Co., Philadelphia.—A handsomely executed pamphlet containing illustrated descriptions of Fielding specialties for window lighting with incandescent lamps.

INCANDESCENT LAMPS. The Colonial Electric Company, Ravenna, Ohio.—An illustrated catalogue of the Colonial incandescent lamp, which is made in all of the standard candle-powers, voltages and bases.

CALENDAR. The R. M. Cornwell Co., Syracuse, N. Y.—This is a hanging calendar of the familiar pad type, the monthly leaves being fastened to a large paper backing bearing a fancy picture lithographed in colors.

HYDRAULIC TURBINES AND CENTRIFUGAL PUMPS. I. P. Morris Co., Philadelphia.—Bulletin No. 1, containing illustrations and descriptions of some notable turbines and pumping machinery built by this company.

CALENDAR. Pope Manufacturing Company, Hartford, Conn.—A desk calendar for 1905 of the familiar pad memorandum type, containing a separate leaf for each day of the year with a blank space on each leaf for memoranda.

PISTON-ROD PACKING. Holmes Metallic Packing Company, Wilkesbarre, Pa.—A pocket-size catalogue containing a brief description of this packing and illustrations of a number of representative engines on which it is used.

ALTERNATORS. General Electric Company.—Bulletins Nos. 4393 and 4394, containing illustrated descriptions of engine-type and belt-driven revolving-field alternators, each having its exciter incorporated in the main structure.

FOUNDRY APPLIANCES. W. W. Lindsay & Co., Philadelphia.—A well-executed pamphlet of vest pocket size devoted to chaplets and anchors for foundry use. The book is illustrated and contains very complete data and price lists.

STATIC ELECTRICITY NEUTRALIZED. The Portland Company, Portland, Me.—A bulletin containing a description of apparatus devised for neutralizing the static electricity generated by friction on finished paper passing through calendar rolls.

HOUSE TANK PUMPS. The Prindle Pump & Engineering Company, New York.—This is catalogue A, of standard size, containing illustrated descriptions of the Prindle motor-driven centrifugal pumps for use chiefly in connection with house tanks.

COMPENSATED GENERATORS. The Ridgway Dynamo & Engine Company, Ridgway, Pa.—Bulletin No. 14 devoted to the well-known Thompson-Ryan compensated direct-current generator. The bulletin is liberally illustrated and well executed.

GAS AND GASOLINE ENGINES. Marinette Gas Engine Company, Chicago Heights, Ill.—A well-executed catalogue, containing illustrated descriptions of the Walrath gas and gasoline engines which are built in vertical single, double and triple-cylinder styles.

REFLECTORS. Sunlight Reflector Company, Brooklyn, N. Y.—Catalogue No. 6, containing illustrated descriptions and price lists of mirror reflectors of all of the usual shapes for individual lamps, clusters, window fixtures, boiler lights, church ceiling fixtures, etc.

ELECTRIC COOKING AND HEATING APPARATUS. The Prometheus Electric Company, New York.—Leaflets Nos. 1 and 2, containing illustrated price lists of Prometheus food and water heaters, coffee pots, tea kettles, chafing dishes, radiators, sad irons, etc.

THAWING FROZEN WATER PIPES. Pittsburg Transformer Company, Pittsburg, Pa.—An illustrated pamphlet containing a description of this company's special transformer built for pipe-thawing service. The transformer was described in the December number of the AMERICAN ELECTRICIAN.

PUMPING MACHINERY. Henry R. Worthington.—Catalogue W-30 of standard size, devoted to the well-known line of Worthington pumps, both direct-acting, steam-driven and centrifugal pumps driven by different forms of prime movers. The catalogue is profusely illustrated and beautifully executed.

CONDENSING APPARATUS. The Deane Steam Pump Company, Holyoke, Mass.—Catalogue D-23, devoted chiefly to Deane jet and surface condensers, vacuum pumps, air and circulating pumps, etc., and also containing some other useful information on the application of condensers to steam engines in general.

ILLUMINATION. Holophane Glass Company, New York and Chicago.—Two beautifully-executed brochures, one entitled "The Lighting of the Home," and the other, "Lighting vs. Illumination." Both contain a large amount of useful information concerning the distribution of artificial light and the relation of the Holophane glassware thereto.

MECHANICAL STOKERS. The Westinghouse Machine Company, Pittsburg, Pa.—This is a handsome publication of standard catalogue size, opening at the end, devoted to the Roney mechanical stoker. It contains a brief illustrated description of the stoker, some information as to the conditions under which these stokers are in operation, and numerous illustrations of plants already installed.

THE WINTER BOARDER. New York Central & Hudson River Railroad Company.—This is No. 36 of the well-known "Four Track" series of publications, and it contains a list of the principal hotels in New York City and all of the hotels and boarding places in the towns and cities reached by the New York Central system. This company has also issued No. 5 of the "Four Track" series, entitled "America's Winter Resorts," and containing a great deal of useful information concerning such resorts and maps showing the scope of the New York Central's railway system.

CALENDAR. John A. Roebling's Sons Co., New York.—A most convenient vest pocket calendar comprising a "Petite" calendar and stamp case containing a calendar for the entire year bound in flexible leather, and a somewhat larger flexible leather binder adapted to carry a stitched-leaf calendar book for one month. Twelve stitched monthly books accompany the binder and the substitution of each month's book is a matter of a few seconds. Each leaf of the monthly book contains the day of the week and the day of the month with ample space for memoranda.

ELECTRICAL MEASURING INSTRUMENTS. Keystone Electrical Instrument Company, Philadelphia, Pa.—This is catalogue No. 12 of standard size, containing illustrated descriptions of the Keystone line of instruments which include the electro-dynamometer type built in all standard forms and the solenoid type built for switchboard service. The Keystone Company calls attention to the recent court decision in its favor concerning the manufacture of the electro-dynomometer type of instrument. This decision reversed a previous decision of a lower court, which had held the Keystone instruments to infringe Weston patents.

BUSINESS NEWS.

GREEN ENGINEERING COMPANY, Chicago, announces that the Green traveling link-grate stoker was awarded the gold medal at the St. Louis Exposition.

MODEL STOKER COMPANY, heretofore of Akron, Ohio, has removed its factory and headquarters to Dayton, Ohio, where much more advantageous facilities have been secured.

THE NORTH ELECTRIC COMPANY, Cleveland, Ohio, has established a branch office at Dallas, Tex., in charge of Mr. A. A. Miller, who has for some time past been connected with the sales department at the home office.

FELTEN & GUILLEAUME, Mulheim-on-Rhine, Germany, are finding a most gratifying demand for the new cable grip recently put on the market. This device was described in the reading pages of our November, 1904, number.

EMPIRE STATE DRY BATTERY COMPANY has been organized by Mr. John Smith, formerly superintendent of the Electric Contract Company's factory. The new company has well-equipped works at No. 80 Fulton Street, New York.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, through its Agents, G. & O. Braniff & Co., of Mexico, has been awarded the contract for all of the electrical apparatus to be installed by the El Oro Mining and Railway Company, El Oro, Mexico. This contract amounts to nearly $100,000.

THE BURT MANUFACTURING COMPANY informs us that the statement made in our Personal column last month concerning the former relationship of Mr. Edward James to that company was inaccurate. The Burt Co. states that Mr. James was not in charge of its filter department, but represented that department in Pittsburg and vicinity.

ELECTRICAL EQUIPMENT & SUPPLY COMPANY, Pittsburg, Pa., reports that on accounts of the rapid increase in its business it has been found necessary to take larger quarters. The company is therefore moving from 215½ Fourth Avenue to 336-338 Second Avenue, where it will occupy three floors and the basement.

THE TRUMBULL ELECTRIC MANUFACTURING COMPANY, Plainville, Conn., has increased its line of specialties considerably. The company now builds a most complete line of panel boards, switchboards, switches, fuses and fuse-holders. A catalogue of the full lines will be ready for distribution by the time this paper reaches its readers.

THE A. D. GRANGER COMPANY has moved its Philadelphia office to the Commonwealth Trust Building, Chestnut and Twelfth Streets, where much larger and commodious offices have been fitted up. Mr. T. M. Simpson remains as manager of this office, his territory covering all of that portion of Pennsylvania from Harrisburg to Philadelphia and the southern half of New Jersey.

CONSOLIDATED ENGINE STOP COMPANY, New York, are rather pleased by a reference to the prompt action of their apparatus which was made in a recent court decision relating to a damage suit. The court ruling was based on the judge's acceptance of testimony to the effect that

the automatic engine stop had brought the machinery to a standstill as quickly as it was possible to do so.

ABNER DOBLE CO., San Francisco, has been awarded the Grand Prize for its St. Louis exhibit of a 170-h.p. tangential water wheel. This is the highest award given by the experts at the St. Louis World's Fair. The wheel develops 170 horse-power at 700 r.p.m., with a water pressure of 300 pounds per square inch (equivalent to a hydraulic head of nearly 700 feet). It was direct-connected to a 100-kw. railway generator and was one of the units of the intramural power plant.

PAYNE ENGINEERING COMPANY, New York, reports good business in the engines of its make. Among recent sales were the following: Three 130-h.p. engines for direct connection to dynamos in the Kilmer Building, Binghamton, N. Y.; two 115-h.p. and one 80-h.p. engines for similar service in a New York hotel; two 80-h.p. engines, direct-connected, for Gouverneur Hospital, New York; one 120-h.p. engine, direct-connected, for the New Jersey Zinc Company; one 80-h.p. direct-connected engine for a Brooklyn hotel.

KEYSTONE LUBRICATING COMPANY, Philadelphia, has brought out a new lubricant particularly intended for the electrical field. It is known as No. 6 density grease, and is made for use in all places where lubrication is required, excepting engine cylinders. It is very thin, practically a liquid, and can be applied from an ordinary oil squirt can. The company guarantees this new lubricant to reduce the temperature of any bearing practically to the temperature of the room, and states that one pound of it will go farther than three to four gallons of the best lubricating oil.

BROWN CORLISS ENGINE COMPANY, Corliss, Wis., has secured, in the face of unusually strong competition, a contract to build a large triple-expansion, high-duty pumping engine for the city of Milwaukee. The engine is to be capable of handling twenty million gallons of water an hour, and the contract price was $64,500. There was considerable discussion of the ability of the company to handle such a large piece of work, but a visit to its works by the City Engineer and the Commissioners of Public Works satisfied those gentlemen on that point.

CENTRAL STATION NEWS

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

ALABAMA.

ATTALLA.—A. L. Du Pre and J. R. Brown, of this city, together with Adolphus Brown, of Ragland, have filed articles of incorporation for the Etowah Light & Power Company. The company is capitalized at $24,000 and its principal place of business will be here. A. L. Du Pre is president, J. R. Brown, vice-president, and Adolphus Brown, secretary and general manager. The company has purchased the water power of W. P. Lay on Wills Creek and will generate electricity for lighting and power purposes in Gadsden, Attalla and Alabama City.

ARKANSAS.

COTTER.—Work is well under way on the ice and electric light plant here.

CLARKSVILLE.—E. T. McConnell, of Eureka Springs, is making arrangements to construct an electric light plant here.

RUSSELLVILLE.—Dr. Robert Smith and several other prominent business men have purchased the electric light plant, which was controlled by Smallwood & Sons.

FORREST CITY.—Reports state that the plant of the Forrest City Electric Light & Power Company has been sold to Capt. George M. Mead, of Little Rock, and some Memphis parties.

POCAHONTAS.—S. C. Dowell, of Walnut Ridge, has been granted a franchise for the Pocahontas Power Company, of which he is president and treasurer. He writes that it is proposed to construct an electric light plant to cost about $25,000.

BATESVILLE.—The Batesville Power Company has been incorporated with a capital stock of $10,000, by F. P. Allbright, William Ramsey and A. R. Weaver. The company will develop water and steam power for the generation of electricity for commercial and manufacturing purposes.

CALIFORNIA.

SAN FRANCISCO.—Jacob Schiff and other New York parties are trying to get a franchise for an opposition electric light and gas plant here.

CALISTOGA.—Bids will be received January 3 by the Town Clerk for a franchise to establish an electric light and power system in this town.

ORANGE.—A resolution has been adopted by the Council providing for the construction of water works and an electric light plant at this place.

NEEDLES.—It is reported that the Murphy Water, Ice & Light Company will construct an independent electric light plant to be used for lighting the city.

COLORADO.

GOLDFIELD.—Rodney Curtis, of the Denver Tramway Company, Denver, is reported to be interested in the construction of an electric plant on Bishop Creek to supply electricity to this town and Tonopah.

COLORADO SPRINGS.—Incorporation papers have been filed by the San Luis Valley Irrigation, Land & Power Company with a capital stock of $1,000,000. A dam will be constructed across the Rio Alamosa River and water will also be taken from other natural streams in San Luis, El Paso, Conejos and Rio Grande counties and used for irrigating lands in those counties. In addition to the irrigation enterprse, the company will establish an electric power plant for generating and distributing electricity to towns and cities in the district mentioned. The directors are S. S. Bernard, William M. Bainbridge, M. F. Stark, W. A. Braiden and W. O. Mieir. The principal offices will be maintained at Colorado Springs.

CONNECTICUT.

HARTFORD.—H. B. Freeman, Jr., of Hartford, and twenty others have prepared a petition to the general assembly of Connecticut applying for a charter for a new electric plant which will furnish power and light in the counties of Hartford and Litchfield. It is planned to install the plant in the mills of the Cotton Duck Trust Company in New Hartford.

NEW MILFORD.—It has been announced that the New Milford Power Company, the largest of its kind in Connecticut, and which furnishes power for trolley systems in Waterbury, New Britain and Bridgeport, and several smaller towns on the line of the Connecticut Railway and Lighting Company, has been reorganized. The new officers are: President, Winthrop G. Bushnell; vice-president, Louis E. Stoddard; secretary and treasurer, Samuel C. Morehouse. The company has an extensive plant in New Milford and an auxiliary plant is being built at Boardman's bridge. Offices will be established in New Haven.

FLORIDA.

GRACEVILLE.—The secretary and superintendent of the Graceville Light & Water Company, writes that the proposed water works and electric light plant will cost about $20,000. Ludwig & Co., of Atlanta, Ga., the engineers in charge of the work.

GEORGIA.

DALTON.—It has been decided by the City Council to construct an electric light and power plant.

GRIFFIN.—The contracts which have been let for putting in a sewerage system and making improvements to the light and water plants of this city are said to aggregate $100,000.

ATLANTA.—The Peachtree Lighting Company has been granted a charter to supply electric lights to the residents of Peachtree Road and other places in the county. The company is capitalized at $600, with the privilege of increasing the capital stock to $5000, and is composed of Arnold Boyles, Martin Amorous and Edwin Brown.

DALLAS.—The Dallas Light & Power Company has been organized by the citizens. A. J. Cooper was made president and E. H. Robertson, secretary and treasurer. The company's capital is $5000 and a charter will be applied for at once. It is proposed to erect an electric light plant first and later a complete water works system will be installed.

IDAHO.

BOISE.—I. B. Perrine is said to be interested in the construction of an electric plant on Trout Creek.

MONTPELIER.—The Montpelier Electric Light Company has increased its capital stock from $25,000 to $40,000.

IDAHO FALLS.—The Idaho Power & Transportation Company is reported to have in contemplation the construction of a dam near this city, and later, the construction of an electric power plant.

ILLINOIS.

ST. CHARLES.—Extensive improvements are being made at the city's electric light plant.

CAYUGA.—The City Council is investigating the cost of establishing an electric light plant.

AMBOY.—The Amboy Lighting & Power Company has changed hands, it is said, Mr. Searles being named as the purchaser.

ROCK ISLAND.—The Council has approved a contract with the People's Power Company to furnish light and power for the reservoir plant and the water works plant.

BELLEVILLE.—The Ada Electric & Gas Company has filed articles of incorporation, with a capital of $100,000. J. A. Hamilton, A. R. Daab and L. D. Turner, Jr., are the incorporators.

MACKINAW.—A franchise has been granted by the Board of Trustees to a stock company organized for the purpose of rebuilding the electric plant which was recently destroyed by fire. The incorporators are S. A. Thompson, George Tyrrell and C. G. Sparks, and the capital stock is placed at $10,000.

MORRISON.—George A. Whitcomb, one of the incorporators of the Rock River Hydro-Electric Milling and Power Company, writes that it is proposed to build a dam across Rock River at Lyndon, Ill., and construct a power plant of from 1600 to 2500 horse-power. Work will be commenced early in 1905.

MOLINE.—The People's Power Company, of this city, has increased its capital stock from $600,000 to $1,000,000. Among the improvements contemplated are an addition to the old plant, the purchase of a 2500-h.p. generating unit, connections to be made to additional water wheels and a building for purifying gas.

INDIANA.

LEBANON.—Edmund Connor, City Clerk, writes that a franchise has been granted to the Citizens' Electric Light & Ice Company.

DUNKIRK.—The Dunkirk Lighting Company has been incorporated by Charles A. Harkins, Charles O. Reynolds and Jesse M. Soper, with a capital of $21,000.

KOKOMO.—George Kingston, John W. Johnson and Edward S. Huff have filed articles of incorporation for the Kokomo Electric Company, with a capital of $10,000.

CHRISNEY.—The Chrisney Electric Light Company has been incorporated, with a capital of $1500.

The directors are J. C. Fella, B. N. Fish, J. M. Fella and John B. Chrisney.

TERRE HAUTE.—The Board of Public Works has recommended to the City Council the bid of the Terre Haute Traction Company for lighting the streets for a period of five years at $75 per lamp per year on an all-night schedule.

MATTHEWS.—Articles for the incorporation of the Matthews Electric Light & Power Company, with a capital stock of $15,000, have been filed at the Auditor's office. The directors are Philip Hughes, Guy S. Rinebolt, E. W. North, Everett W. Trook, and others.

EVANSVILLE.—The Evansville Gas & Electric Light Company has secured the contract for lighting the city for five years at the following bid: Electric arc lights of 2000 candle-power at $67 per lamp per year; incandescent gas lights at $20 per lamp per year, and gas at $1 per thousand cubic feet for lighting public buildings.

INDIAN TERRITORY.

RAMONA.—The Ramona Light, Heat & Power Company has filed articles of incorporation.

IOWA.

CRESTON.—E. M. Springer and Mr. Harrison, of Red Oak, are making arrangements to establish a new electric light and heating plant in Creston.

CLARKSVILLE.—The plant of the Clarksville Light, Heat & Power Company is said to have changed hands recently, the purchaser being Willis Sutcliff.

CLARINDA.—The Lee Electric Light Company has been incorporated, with a capital of $50,000. Mr. R. B. Lee is among the incorporators.

DAVENPORT.—The People's Power Company has increased its capital stock from $60,000 to $1,000,000 and will make extensive improvements to its property during the coming year.

LEON.—The municipal electric light plant has been sold to W. S. Curtis and H. E. Chase. The new owners will improve and enlarge the plant and endeavor to render an efficient and up-to-date service.

FAIRFIELD.—The Fairfield city council has entered into a contract with the Western Electric Company, of Chicago, for a new lighting plant to be installed in this city as soon after the first of the year as possible. There will be seventy-five lamps, each 2000 candle-power. The dynamo of the present lighting plant will carry fifty lamps, so that there will be at least one hundred and twenty-five lamps. The price of the new plant will be $2,735.

KANSAS.

ELDORADO.—W. Martin Jones has been granted a franchise to establish an electric light plant here.

MANHATTAN.—C. P. Dewey, of Chicago, has been re-elected president of the Manhattan Ice, Light & Power Company.

KENTUCKY.

STURGIS—Mark E. Easton, Mayor, writes that a twenty-year franchise has been granted to the Sturgis Electric Light Company, of this town.

FULTON.—It is rumored in business circles that local capitalists are interested in the construction of a new electric light plant in Fulton, but nothing definite is known as yet.

LOUISIANA.

LAKE PROVIDENCE.—The City Council has let the contract for constructing the municipal light and water plant to A. B. Sanders, of Shreveport, for $37,000. Arthur Hider, of Greenville, Miss., is the engineer in charge of the work.

MAINE.

FORT FAIRFIELD.—The Fort Fairfield Electric Company has been organized by Harry L. Cram and A. J. Desmond, both of Portland, for the purpose of furnishing gas and electricity in Fort Fairfield. The company's capital is $40,000.

MARYLAND.

LUTHERVILLE.—It is reported that the Baltimore County Commissioners expect to install an electric lighting system in the village shortly.

BALTIMORE.—Mayor Timanus has signed the franchise authorizing Richard B. Fentress and Summerfield B. Medairy to use the city subway for the transmission of electricity for lighting and power purposes and also to erect poles and string wires outside the subway district. Arrangements have been made with the Baltimore Refrigerating & Heating Company for the generation of electricity at its large plant on South Eutaw Street. This power will be distributed by Messrs. Fentress and Medairy, who have already secured a number of large contracts in the new district, it is said. The Refrigerating & Heating Company is at present installing an additional battery of boilers of 1000 horse-power capacity and the necessary electrical machinery will also be put in at once; it is proposed to expend about $1,000,000 in new apparatus. Messrs. Fentress and Medairy have begun stringing the wires.

MICHIGAN.

BERRIEN SPRINGS.—J. Du Shane, of South Bend, Ind., writes that it is proposed to construct a power dam at this place, but that nothing will be done this season. The cost of the work is estimated at about $1,000,000.

DETROIT.—At a recent meeting of the Council, John Russell petitioned the Springwells Township Board for an electric lighting franchise for that portion of Springwells Township not included in the villages of Woodmere and Delray.

JACKSON.—A big power dam project is under way to furnish power for electric lighting for Whitehall and Montague and other purposes. R. H. Updyke, a civil engineer from Grand Rapids, has been working for the last two years on a plan and has the details nearly completed for the damming of White River and the construction of a large power house on the dam. A forty-foot head of water will be maintained and in the power house will be large dynamos which will generate enough power to transmit current for electric lighting, pumping and for electric cars as far as Grand Rapids.

MINNESOTA.

GREY EAGLE.—Guy Robbins has secured a franchise for an electric light plant here.

MIDWAY.—The Electric Light & Power Company, it is said, expects to erect a new plant here.

JORDAN.—The Jordan Electric Light & Heating Company will shortly increase its equipment by the addition of a storage battery system.

ANOKA.—The Anoka Water Works, Electric Light & Power Company expects to add to its equipment a new dynamo of 2000 lights capacity.

AITKIN.—The Aitken Power & Light Company has filed articles of incorporation, with a capital of $10,000. Clark S. Kathan and Nelson I. Cluff are among the incorporators.

WINTHROP.—The Electrical Machinery Company, of Minneapolis, secured the contract for making the extensions and improvements at the electric light plant and water works for $7530.

MANKATO.—Plans and specifications are being prepared for a complete railway, light, heat and power plant to be installed shortly by the Mankato Railway, Light & Power Company.

BAGLEY.—Bids will be received January 3 by the Village Council for bonds to the amount of $13,000, the proceeds to be used in purchasing an electric light plant and constructing a water works system.

MINNEAPOLIS.—An ordinance has been introduced in the Council, providing for a 30-year franchise to the Minnesota Power & Trolley Company, of Champlin, to erect poles and string wires for the transmission of electricity to this city.

MINNEAPOLIS.—The Rainy River Improvement Association, with a capital of $5,000,000, has been incorporated to build a concrete dam across Rainy River to raise the lake and thus furnish more power. The incorporators are E. W. Backus and A. E. Horr, of this city, and H. B. Winchell, of Butte, Mont.

MINNEAPOLIS.—The Council Committee on Lighting has recommended that contracts for lighting the city for the year beginning January 1 be awarded as follows, all being on the all-night schedule: The Minneapolis General Electric Company for street arc lights at $94 per lamp per year; the Minneapolis Gas Light Company for gas at 95 cents per thousand cubic feet, and the Patterson Street Lighting Company, of Cleveland, for incandescent fixtures and maintenance at $13.40 per lamp per year.

MISSISSIPPI.

GRENADA.—The Council is making arrangements to enlarge the electric light plant.

HATTIESBURG.—The City Council has granted to G. L. Hawkins and associates the right to erect, maintain and operate an electric lighting plant in Hattiesburg. The franchise includes the right to lay single or double tracks and everything pertaining to a first-class street railway system, and is for twenty-five years. The company shall by June 1, 1905, commence work in good faith, and complete, equip and have in operation at least three miles of its line not later than January 1, 1906. It is rumored that Captain J. T. Jones, president of the Gulf & Ship Island Railroad, is an interested party with Mr. Hawkins.

MISSOURI.

HANNIBAL.—Work is progressing rapidly on the new city electric light and power plant here.

GLASGOW.—A franchise has been granted for the construction of an electric light plant here, and it is understood that work on the new system will soon begin.

CHILLICOTHE.—At an election held recently, the citizens voted to have the electric lights turned off rather than pay an advance of $7 per light on the present cost.

BOWLING GREEN.—Thomas Melvin, formerly of New York City, has leased the electric light plant here from N. H. Ledford, and intends to make extensive improvements in the near future.

JEFFERSON CITY.—The citizens have voted to extend the franchise of the electric light and gas company for twenty years and the company, it is said, has agreed to expend $75,000 in improving the plant.

ST. LOUIS.—The Security Electric Heating & Power Company, with a capital stock of $300,000, has filed articles of incorporation. Among those interested in the undertaking are Samuel D. Winter and Dudley S. Wageley.

EL PASO.—The El Paso Gas & Electric Company has filed articles of incorporation, with a capital of $500,000. Among the incorporators are William Barrett Ridgely, Washington, D. C.; George Goodnow, Waukegan, Ill., and Charles Barrett, of this city.

ST. LOUIS.—Reports state that the Union Electric Light & Power Company's plant was damaged by fire recently to the extent of about $5500. The company has secured a building permit for the erection of a sub-station at 709 North Fourth Street. The new station is to cost $26,000.

HALE.—Preparations for the erection of an electric light plant at this point are being made. The company which has the project in hand will be known as the Citizens' Electric Light & Land Company. A. J. Herren is president; W. L. Ballow, secretary and treasurer, and Fred Halbauer, general manager.

JOPLIN.—Press reports state that the Spring River Power Company, of Kansas, has filed articles of incorporation in this state to show that it had been incorporated under the laws of the State of Missouri, with a capital of $450,000, of which $50,000 is to be employed in Missouri. The company is also to have an office in this city.

MONTANA.

LIVINGSTON.—C. S. Hefferlin has applied for a thirty-year franchise for an electric light and power plant.

WHITEFISH.—The Big Fork Electric Power & Light Company is said to have secured a franchise for its pole line from Kalispell to this city.

WHITEFISH.—George Nixon, of Spokane, Wash., is making surveys for an electric light plant and water works, the power to be developed from Hell Roaring Creek.

NEBRASKA.

CRAB ORCHARD.—A municipal electric light and power plant is to be installed here.

OMAHA.—The Baxter Springs Electric Company has been incorporated with a capital of $30,000.

EDGAR.—The City Council has granted a franchise to Keefe & Larkin for lighting the city by electricity. They will erect a plant at once.

NEVADA.

GOLDFIELD.—A project is under way to supply this camp and Tonopah with electric lights and power from Bishop Creek, Inyo County, California, and the probabilities are that the work on the great undertaking will begin within a few weeks. Denver and Goldfield parties are behind the scheme, which involves the expenditure of nearly a half million dollars and the running of feed wires from Bishop to Goldfield and Tonopah, a distance of eighty miles, directly across the White Mountains. Already water rights have been secured on Bishop Creek and surveys for the plant and the wire lines have been made.

NEW JERSEY.

PERTH AMBOY.—The Public Service Corporation has secured the contract for lighting the city for five years at $97.50 per lamp per year.

BRIDGETON.—City Recorder Frank L. Hewitt writes that the Council has awarded the contract for lighting the city for a period of five years to the Bridgeton Electric Company.

JERSEY CITY.—The North Jersey Electric Light, Heat & Power Company has filed articles of incorporation, stating its capital stock to be $100,000. F. J. Smith and B. P. Tracy are among those interested in the new concern.

NEWTON.—The Newton Gas & Electric Company has replaced its old street arc lamps with others of an improved pattern. When the new plant, now in course of construction, is completed the company will institute a 24-hour service instead of the present night service.

TRENTON.—The City Council at a recent meeting adopted a resolution providing for the appointment of a committee with power to investigate the advisability of constructing an electric light plant. Messrs. Throp, Fischer and Stilwell were appointed members of the committee.

IRVINGTON.—The United Electric Company has been awarded the contract for lighting the city for a period of five years at $15 per lamp per year for a 30-c.p. light. This disposes of the question of municipal ownership of a lighting plant, which has been under discussion here recently.

JERSEY CITY.—The Michigan Light Company, with an authorized capital of $2,250,000, has been incorporated by Walter B. Mahoney, Walter Thiele and Charles N. King, all of this city. The company's office will be in Jersey City, and it is proposed to construct and operate heating and lighting plants.

EAST NEWARK.—After much discussion, the Common Council has accepted a contract submitted by the Public Service Corporation to supply light to the borough at the rate of $100 per lamp per year, which is a reduction of $7 per lamp from the former price. The contract is to run five years, from July 1, 1904.

NEWARK.—The Middlesex Lighting Company of Newark has been incorporated to generate and distribute electric current for light, heating and power purposes. The company is capitalized at $100,000, and among the incorporators are Albert B. Carlton, Elizabeth; Percy S. Young, Passaic, and Frederick Evans, New York City.

PASSAIC.—The City Council has awarded the contract for lighting the city streets for five years and furnishing the incandescent lamps to the Weehawken Construction Company at the following bid: Arc lights $88 each per year; incandescent street lights, $15 per year; incandescent lighting for public buildings, 10 cents per kilowatt-hour; incandescent lighting to private individuals, not more than 10 cents per kilowatt-hour. The company further agrees to erect and have in operation within eight months from the date the contract is signed a complete plant, fitted with the most up-to-date equipment.

KEARNY.—Two electrical experts have submitted estimates to the lighting committee of the cost of a municipal electric light plant. One of the estimates placed the cost at $50,000, while the other showed figures of $55,000. As the Council desires sufficient time in which to erect a plant, and the present contract with the Public Service Corporation expires August 1, 1905, a resolution was adopted requesting Clerk Wildman to secure bids for lighting the town. At the opening of the bids that of the Public Service Corporation was found to be the only one submitted, and it was decided to return it and call for other bids.

NEW YORK.

BROOKLYN.—The Astoria Light, Heat & Power Company is arranging to put up a new building to cost $140,000.

LIVONIA.—F. A. Wicker, B. C. Black and Elbert Long are said to be interested in the construction of an electric light plant here.

HUNTINGTON.—The Huntington Light & Power Company has absorbed the Huntington Gas Company, of which Edgar L. Street is president.

CANANDAIGUA.—There is some talk here of constructing a municipal electric light plant. The subject will probably be voted upon at the annual election in February.

BUFFALO.—The Phelps Lighting Company, with a capital stock of $50,000, has filed articles of incorporation. William Hooker, of Batavia, and E. W. Phelps are on the board of directors.

MASSENA.—The St. Lawrence Transmission Company has been incorporated to generate and distribute electricity for light, heat and power purposes. The company's capital is $25,000.

HARRISVILLE.—The Harrisville Electric Light & Power Company has been incorporated with a capital of $10,000. The directors are Thomas J. Wilbur, Joseph Weeks, Sr., and J. E. Harney.

LOCKPORT.—Engineers are at work laying out the final survey for the power canal to be constructed by the Niagara, Lockport & Ontario Power Company. Robert E. Drake and Paul T. Brady, of Syracuse, are directors of the company.

ALBANY.—The Northern Westchester Light & Power Company has filed articles of incorporation, with a capital of $5000. R. S. Hull, of Brooklyn; A. S. Andrews, of Flushing, and John Larkin, of New York, are the organizers of the enterprise.

NEW YORK CITY.—The Board of Estimate has passed a resolution authorizing Corporation Counsel Delaney to prepare an amendment to the charter to be presented at the coming session of the Legislature providing for the establishment of a municipal electric lighting plant.

NORTH TONAWANDA.—The Home Electric Light & Power Company has petitioned the Board of Aldermen for a franchise to string and maintain the necessary cables and wires for the distribution of electricity for lighting and power purposes. The company will use the poles of the Niagara County Home Telephone Company.

VALLEY STREAM.—A company, known as the Queens-Nassau Electric Light & Power Company, has been incorporated. The company will do business in Nassau, Queens, Kings, Suffolk, Richmond and Westchester counties. The capital stock is placed at $100,000, and the directors are G. F. Swinnerton, A. Foshay and R. K. Tompson.

NEW YORK CITY.—The Commonwealth Electric Company has made application for a charter in Pennsylvania, and efforts are being made to secure a complete light and power franchise for this company in Philadelphia in competition with the Philadelphia Company. It is reported that George R. Sheldon is connected with the Commonwealth Company.

MIDDLETOWN.—Philip N. Jackson, who recently bought the property of the Orange County Gas & Electric Company, proposes to reorganize the company under the name of the Orange Lighting Company, with an authorized capital stock of $100,000 and $300,000 bonds, of which $114,000 will be used to wipe out existing indebtedness and $86,000 be applied toward improving the plant.

MASSENA.—Norman K. Devendorf, chief operator of the Hudson River Water Power Company and formerly superintendent of this company's power house at Mechanicsville, has resigned his position with the Hudson River Company to accept a responsible post with the St. Lawrence River Power Company, Massena, N. Y. He will have charge of the company's transmission lines.

NORTH CAROLINA.

TARBORO.—The power house of the city electric lighting plant has been destroyed by fire, entailing a loss of $3000.

MURPHY.—The Murphy Electric Light & Power Company has been chartered by J. Gentry. The capital is placed at $6000.

OHIO.

CANTON.—A franchise has been granted to the Citizens' Light, Heat & Power Company to operate in this city.

IRONTON.—The Board of Public Service is reported to be considering the advisability of installing an electric plant at the city water works.

YOUNGSTOWN.—A committee has been appointed, with R. D. Campbell as chairman, to investigate the matter of installing an electric light plant.

TOLEDO.—F. I. Consaul, City Engineer, is authority for the report that the city is agitating the matter of installing a municipal lighting plant within the next two years. The present contract with the Toledo Railway & Light Company expires January 1, and it is probable that a short-term contract will be made with the same company.

OKLAHOMA TERRITORY.

OKLAHOMA CITY.—Articles of incorporation have been filed by the Banner Electric & Manufacturing Company, with a capital of $10,000. Charles Luck, Charles Risden and Warren Snyder are the promoters of the concern.

ANADARKO.—It has been decided to build a municipal lighting plant and an engineer is now preparing estimates and plans. It is the intention of the Council to operate the lighting system in connection with the water works system, using practically the same power for both.

OREGON.

UNION.—T. H. and C. H. Crawford are interested parties in the installation of a 2500-h.p. plant at this point.

BAKER CITY.—The Baker City Gas & Electric Company has secured the contract to furnish power for the Elkhorn mine. A sub-station will be established near the mine for receiving and distributing the current to the various parts of the mine.

GREENHORN CITY.—C. R. Aldrin, promoter of a plan to establish an electric power plant here, announces that all arrangements have been completed and that work on the plant will be started in the spring. It will be a water power plant with a capacity of 8800 horse-power.

HAINES.—The Town Council has granted to J. F. O'Bryant, of Baker City, a franchise to establish an electric light and power system. The necessary machinery has been ordered and the work is to commence within sixty days. A line will be run from the nearest point on the Rock Creek Power & Transmission Company's line to a sub-station which is to be erected. From here the current will be distributed by means of transformers.

LA GRANDE.—The La Grande Electric Company has consolidated with the Cove Power Company, the former company being in need of more power. The new company has been incorporated under the name of the Grande Ronde Electric Company. Walter Pierce, J. A. Thornton and T. R. Berry are named as the directors. The water from Cove will have a fall of 890 feet and will require 3700 feet of pipe to convey it to the power station, where 800 horse-power will be developed. A transmission line, connecting Cove, Union, Hot Lake, La Grande, and other towns in Union County, will be constructed with as little delay as possible, and it is expected to reach this city by June 1 next.

PENNSYLVANIA.

UPLAND.—Louis R. Page is interested in the establishment of a lighting plant at this place.

NEW MILFORD.—The New Milford Light & Power Company, with a capital of $10,000, has been incorporated.

GROVE CITY.—At a special election held recently it was voted to issue $12,000 bonds for the purpose of enlarging the power house and extending the present system.

HOMESTEAD.—A deal has been closed recently for the purchase of the old Homestead electric plant from T. W. Brockman by the Lawson Manufacturing Company for $13,500.

PHILADELPHIA.—The Commonwealth Electric Company has petitioned the City Council for a franchise to run electric wires for light, heat and power in the conduits owned by the Keystone Telephone Company.

RENOVO.—The Council has decided to call for bids for lighting the streets with arc and incandescent lights. Bids will also be received for the construction of a municipal electric light plant, in order that a more accurate comparison may be made of the relative cost of lighting the town by contract and operating a city plant.

CHAMBERSBURG.—The Borough Council has accepted the bid of Charles Walter, representing the Chambersburg Light, Heat & Power Company, at $75,550 for the electric light plant which the borough has owned and operated for fifteen years. The company entered into a contract to light the streets of the town at $74.50 a year for each arc light.

FOREST CITY.—The Forest City Electric Light, Heat & Power Company, of which A. D. Kelwen is superintendent, contemplates making extensive improvements to its plant, which will enable it to furnish light to the borough of Vandling and also to render improved service here. Estimates on additional equipment, engine and boilers are being considered now.

WILKESBARRE.—Chicago capitalists have purchased the Nanticoke Electric Light & Gas Company, the Plymouth Electric Light & Gas Company, the Kingston Gas Company and the Wyoming Electric Light Company. These companies supply light to eleven towns between Pittston and Nanticoke. Last year they earned in the aggregate $60,000. It is understood the price paid for the property was $602,000. All the plants will now be consolidated and run by one company, with a capital of $1,000,000.

PHILADELPHIA.—It is understood that the only bid received and opened on December 12 for lighting the city by electricity for the year 1905 was submitted by the Philadelphia Electric Company. The bid to light the entire city aggregates $1,137,500. The prices range from 28 cents to 34 cents per light per night. There will be next year 10,312 electric arc lights. The Philadelphia Electric Company has awarded to John R. Wiggins & Co. the contract for the $50,000 building which is to be erected for the company on Penn Avenue.

SOUTH CAROLINA.

GEORGETOWN. — The Georgetown Electric Company has been reorganized, it is said, with H. C. Case, Philadelphia, president, and L. Mouzon, of this city, local manager. Extensive improvements are contemplated.

MARION.—A charter has been issued to the Carolina Water, Light & Power Company, which proposes to operate power plants in this state and elsewhere. The company's capital is $250,000 and the incorporators are J. W. Johnson and W. J. Montgomery.

NEWBERRY.—The Parr Shoals Power Company, of Newberry, has been chartered, the capital stock being placed at $50,000, with the privilege of increasing it to $1,000,000, and the corporators being H. L. Parr, Z. F. Wright, W. G. Houseal, C. H. Cannon, W. K. Sligh and A. L. Scott. The company proposes to develop the great water power on Broad River, near Peak's, between Newberry and Columbia, furnishing electric current to various cities and towns in the State. It is expected that more than 25,000 horse-power will be developed. The Shoals were formerly the property of Mr. H. L. Parr, of this place, but have now been purchased by a joint stock company, which has interested a number of large capitalists. The surveys and measurements have already been made, and it is believed that the power is one of the finest on Broad River.

TENNESSEE.

LAFOLLETTE.—The question of constructing water works and an electric light plant, at a cost of $100,000, is being discussed here.

CLIFTON.—F. A. Mansfield, proprietor of the ice factory, has decided to construct an electric light plant to furnish lights for the town.

MARTIN.—It has been decided by the City Council to install a new engine and dynamo at the water and light plant in order to run a day circuit.

MEMPHIS.—The Committee on Gas and Electricity of the Legislative Council is considering the question of municipal ownership of an electric light plant.

PETROS.—The Big Brushy Coal & Coke Company has completed its new electric light plant which is to supply lights to the town, as well as current for electric haulage and lighting purposes at the mines.

OBION.—J. E. Trout, L. A. Ward, I. Rosenthal, D. A. Dean, George A. Moore, J. W. Buchanan, and James F. Darnell have organized a company, with a capital of $6000, to construct and operate an electric light plant.

TEXAS.

GREENVILLE.—It has been decided not to sell the electric light plant, but bonds for $10,000 will be issued to enlarge and improve it.

DALLAS.—The Oak Cliff Water Supply, Electric Light & Power Company has sold its electric light plant to the Dallas Electric Light & Power Company.

HUMBLE.—A charter has been granted to the Humble Electric Company with a capital of $30,000. It is proposed to install and operate an electric light plant.

JACKSONVILLE.—J. K. Nance, of Ada, I. T., has purchased the plant of the Jacksonville Electric Company and is planning a number of improvements.

MARBLE FALLS.—A 2000-h.p. plant is to be established on the Colorado River at this point, the power to be used to drive machinery for a cotton mill and for lighting purposes.

EL PASO.—The El Paso Gas & Electric Company has been incorporated with a capital of $500,000. It is proposed to supply gas and electric light, heat and power to this city, Juarez, Mex., and other towns. Among those interested in the project are George F. Goodnow, Waukegan, Ill.; Fletcher S. Heath, Chicago, Ill., and Charles Bassett, of this city.

VERMONT.

RUTLAND.—A bill has been introduced in the Legislature granting permission to this city to establish a municipal electric light plant. J. S. Carder is Mayor.

NORTHFIELD.—Village Clerk J. H. Talbot writes that the electric light plant, recently burned, will probably be rebuilt within a year. A contract will be made with Moody & Almon to furnish electricity for one year.

BURLINGTON.—The Northern Electric Company has secured the contract for the interior wiring and fixtures for the buildings, and the erection of poles and the establishment of an arc light system for the exterior lighting of Fort Ethan Allen. The contract for furnishing the current has been awarded to the Burlington Light & Power Company. It will furnish current for interior lighting at 5 cents per kilowatt-hour and for exterior lighting at $78 for each arc lamp. This company will furnish the arc lamps, meters and transformers.

VIRGINIA.

COLONIAL BEACH.—The Colonial Beach Electric & Power Company has been incorporated for the purpose of conducting an electric light and power business. The company is capitalized at $25,000 and its officers are as follows: Warren S. P. Combs, president; F. F. Ninde, vice-president; W. Frank Renshaw, secretary and treasurer.

WASHINGTON.

BALLARD.—Louis V. Brewer has petitioned for a franchise for an electric light plant.

SEATTLE.—The citizens voted December 6 to issue $250,000 bonds for the extension of the present municipal electric light plant. R. H. Thompson is city engineer.

GOLDENDALE.—A. Robinson, of Portland, Ore., secured a franchise to establish and maintain an electric light plant in this town. The plant will be operated by steam power.

PROSSER.—E. F. Benson is said to have secured a controlling interest in the Land & Irrigation Company and expects to put in an electric light plant. An electric road may be built to Sunnyside.

EDMONDS.—The Edmonds Electric Light & Transportation Company recently filed article of incorporation fixing the capital stock at $1,000,000. John A. Hoffman, M. S. Hutton and Frank B. Sayee are among the parties interested in the new concern.

SEATTLE.—The Puget Sound Light & Heat Company, capitalized at $1,500,000, has been incorporated by Alexander Hamilton, Herbert V. Perry and Antony Zurich. There has been considerable discussion over the franchise of this company, together with those of the Mutual Light & Heat Company and the Diamond Ice Company, but it is understood that the Council and all three of the companies have agreed upon amended franchises.

WEST VIRGINIA.

BRUNSWICK.—The Harper's Ferry Electric Light & Power Company is reported to be making preparations to supply this town with electric light. John Leslie, of Hinton, is president of the Harper's Ferry Company.

WISCONSIN.

CASSVILLE.—The Village Council is seriously discussing the question of constructing a village lighting plant.

LA CROSSE.—The Wisconsin Light & Power Company is a concern recently organized with a capital of $200,000. H. A. Salzer and J. J. Hogan are among the incorporators.

ALMA.—The Alma Electric Light Company has been incorporated with a capital of $5000. John Harry, Russell N. Smith, Frank Harry and Charles Schaettle are the incorporators.

CADOTT.—The Cadott Lighting & Power Company has been organized and incorporated by John McGilvray, H. B. Frasil and others. The company has purchased the lighting plant of the Cadott Manufacturing Company. A new alternating-current system will be installed and the plant will be greatly improved. A new power house is to be constructed on the Yellow River.

CANADA.

PALMERSTON, ONT.—It has been decided to issue bonds to the amount of $2500 for electric light improvements.

CALGARY, N. W. T.—The City Council has decided to submit to the people a by-law to raise $60,000 to be used for the purpose of installing a municipal lighting plant.

ST. JOHNS, QUE.—Edouard Beaudry, a Montreal real estate dealer, has purchased the property and plant of the St. Johns Electric Light Company, it is said, in consideration of $300,000.

MONTREAL, QUE.—The water power at Kakapecca Falls is to be developed by Montreal capitalists. The purchasers are Herbert S. Holt, president of the Montreal Light, Heat & Power Company; Charles R. Hosmer, president, and F. W. Thompson, vice-president and general manager, of the Ogilvie Flour Mills Company, Ltd. It is understood that arrangements have been made for the immediate construction of a plant that will have an initial capacity of 30,000 horse-power which will be increased ultimately to 50,000 horse-power.

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TYPICAL FRENCH HYDRO-ELECTRIC AND TRANSMISSION PLANT

THE GENERATING STATION AT CHAMP.

BY EMILE GUARINI.

The hydro-electric station near Grenoble embodies several unusual and interesting features in its hydraulic and electrical equipment. The plant is situated near the junction of the Drac and Romanche rivers, and the power is used exclusively for transmission. The flow of the Drac River varies within very wide limits, and the current is very swift. At Champ the bed of the river is very shallow, so that the width during high water often exceeds one kilometer. It is, therefore, impossible to confine it by a large dam without still further increasing its width. The water is taken from the Drac at Champ by means of a low dam in the bed of the river. This dam is constantly under the river level, but is sufficient to create a current of water from a side outlet having a width of 16 meters (52 ft.), bordering a long intake provided with gratings in the form of light shutters which prevent the ingress of rubbish and stones which are naturally abundant in so violent a stream. The current passing along the side of the intake favors the discharge of gravel and stones through the outlet. What passes the shutters enters the receiving basin. After passing this basin, the water flows into a large settling chamber from which runs a canal 600 meters (1968 ft.) long, terminating in the basin where the pipe line starts. The canal, which starts at the settling basin, has a width varying from 60 to 22 meters (197 ft. to 72 ft.), and a depth from 1.50 to 4 meters (5 ft. to 13 ft.). The water basin which serves as a terminus for the canal and from which the pipe starts is built of concrete. It has a total surface of 900 square meters (9688 sq. ft.). This basin is divided by means of a wall into two compartments. The concrete tube starts from the second compartment and forms the first section of the penstock. The pipe is 3.3 me-

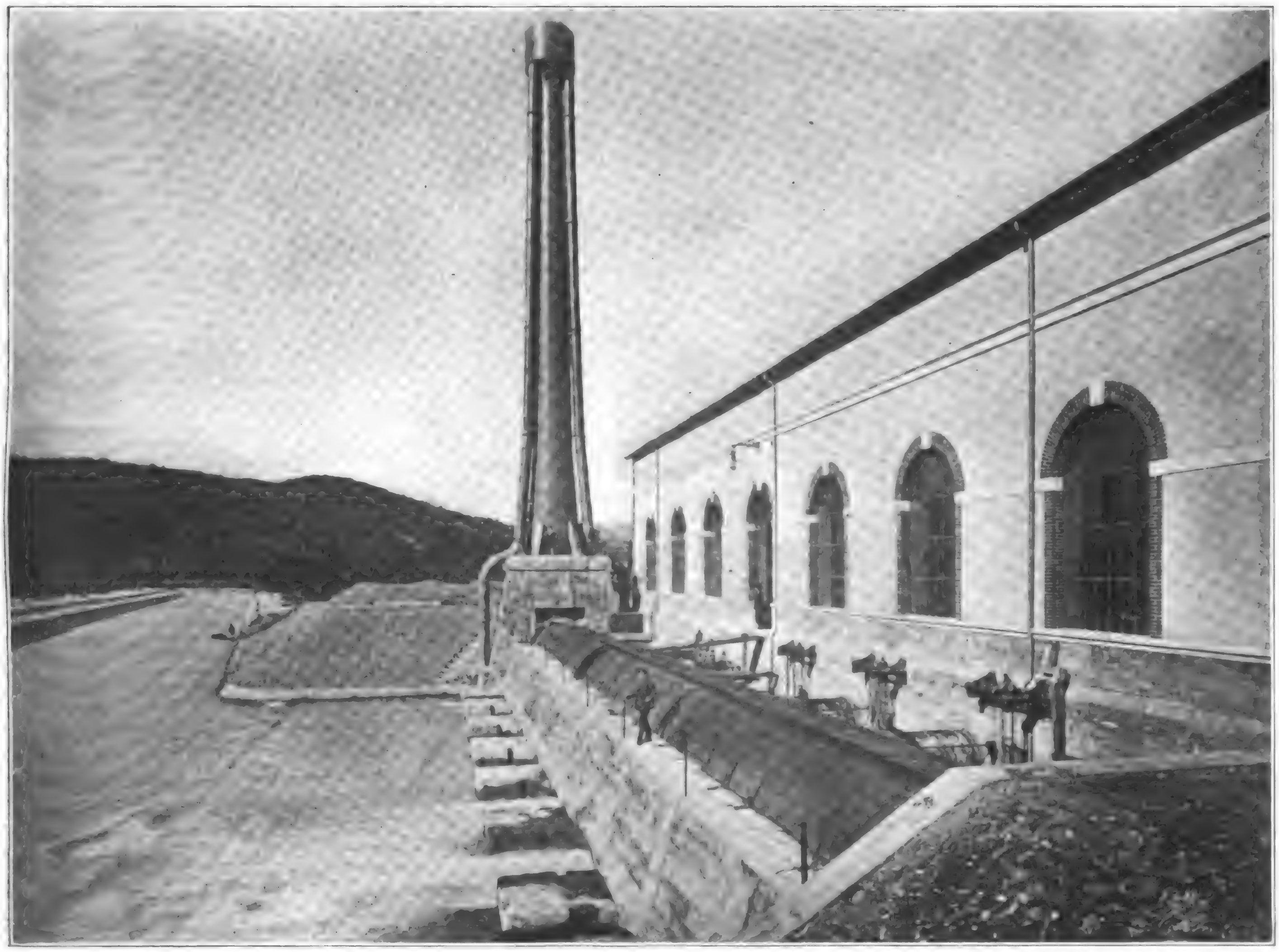

FIG. 1.—POWER-HOUSE, CANAL AND FOREBAY OF THE ELECTRIC GENERATING STATION AT CHAMP.

ters (11 ft.) in diameter, and is 4600 meters (15,090 ft.) long. Of this, 2100 meters (6890 ft.) is formed of re-enforced concrete and 2500 meters (8200 ft.) of sheet steel. The volume of water in the whole length of the penstock is 40,000 cubic meters, flowing with a velocity of 2 meters per second, so that it has been necessary to guard against water hammer in case of an abrupt stoppage at the station. To this end, three standpipes have been placed on the pipe line, two of re-enforced concrete and one of steel.

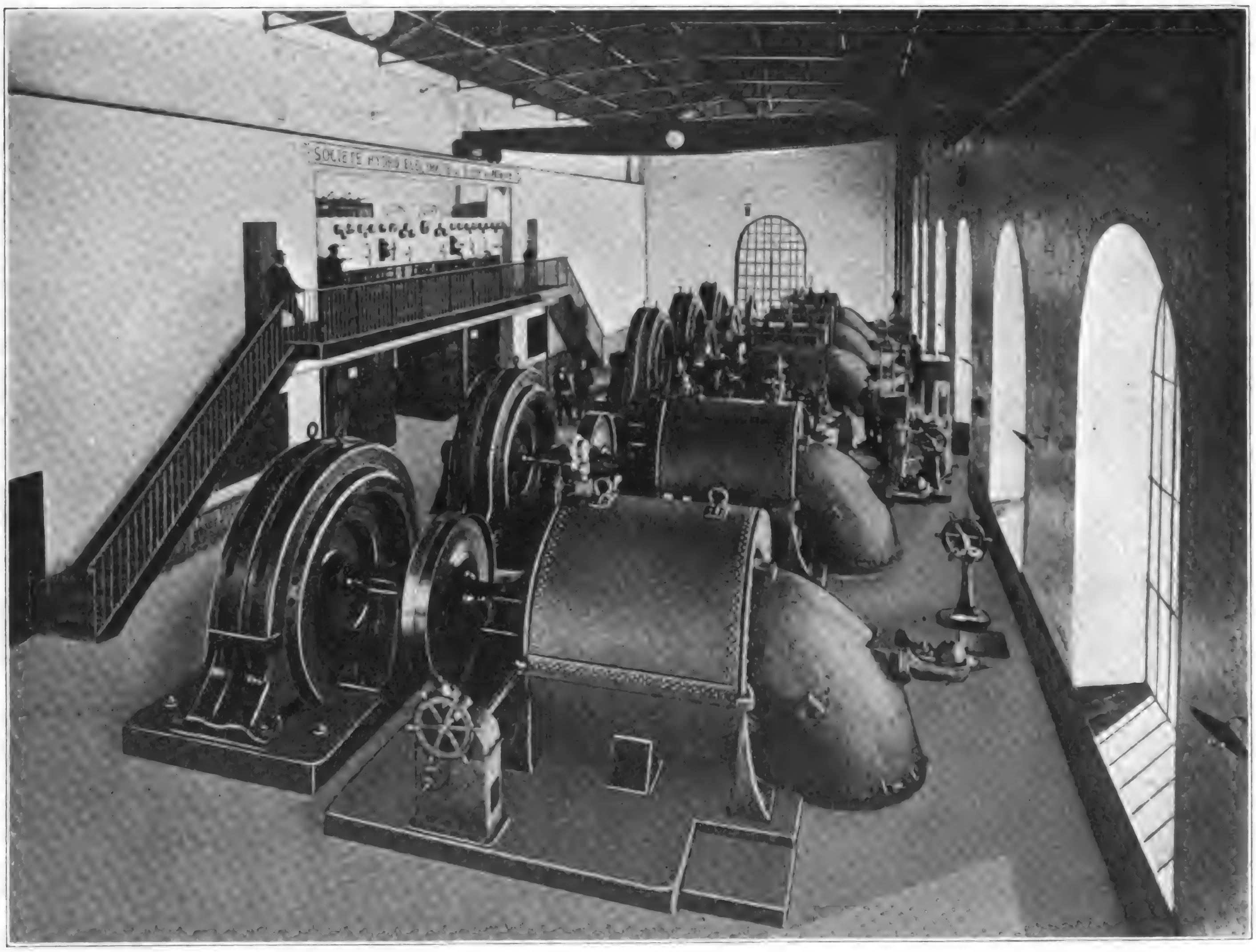

FIG. 2.—INTERIOR OF CHAMP STATION, SHOWING HYDRO-ELECTRIC UNITS AND SWITCHBOARD.

The station contains five generating sets, each rated at 1350 horse-power, and two exciter sets of 150 horse-power each. In addition to these, a small 5-h.p. turbine supplies the hydraulic accumulators necessary for operating the turbine governors. A traveling crane, capable of raising a weight of 15 tons, has been installed here for facilitating repairs and handling the machines. In front of the generating room is the transformer room, supplied with water under pressure. The turbines were furnished by Meyret-Brenier, Grenoble, and the electrical equipment by Brown-Boveri, Baden.

The turbines are of the horizontal-shaft type with a cylindrical distributing chamber, and are attached to the alternators by flexible couplings. Their speed is 300 r.p.m., and they take at full load about 4 cubic meters of water per second. Three of the turbines are furnished with automatic regulators and are supplied with compensating gates. The alternators are of the three-phase type, with revolving fields. Each absorbs at its shaft 1350 horse-power when operating on full load, with a power factor of 0.80. The generators give 3000 volts at 50 cycles per second. The direct-current dynamos which serve as exciters are two in number, and are rated at 150 horse-power each. The armature has a speed of 500 r.p.m. They are shunt-wound machines, and generate current at 115 volts.

The transformers raise the voltage from 3000 to 15,000 or 26,000 volts. These step-up transformers, to the number of five, have each an output of 1150 kilowatts. The cores are disposed in the same plane. The 3000-volt primary windings are subdivided on each phase into three equal parts, placed in series. This provides for the possibility of changing the connections for utilizing a voltage of 1000, by grouping the sections in parallel. The extremities of the secondary bobbins are attached to six terminals, placed on the transformer case, so that a simple movement at the high-tension switchboard will enable the connection of these coils to be made either in triangle or in star, the first giving 15,000 volts and the second 26,000 volts. The cores and windings are submerged in oil cooled by water circulating in a double worm. The weight of each transformer is about 9500 kilograms. A track running into the transformer room allows the transformers to be carried easily to the repair shop, where there is a 10-ton traveling crane.

The switchboards are three in number. They include all measuring apparatus, as well as those for protecting the station. The first is the intermediate tension switchboard; the second, the low-tension switchboard, and the third, the high-tension board. The intermediate tension board is placed on the ground floor between the turbine room and the transformer room. The low-tension board is placed on the second floor on an operating platform. The high-tension switchboard is placed at the middle of the switchboard room on the second floor. Back of the high-tension board are placed the horn lightning arresters, with liquid resistance for protecting the apparatus in the station. At the exit from the station, supplementary lightning arresters have been installed to increase the security. It has been the aim of the design to make the passage of lightning to the ground as direct as possible, with the object of protecting the station apparatus.

The bases of the turbines, alternators, transformers, all frames supporting the electrical conductors, in a word, all metallic parts in the installation, have been grounded by means of two wires, each two millimeters

FIG. 3.—TRANSFORMER ROOM IN CHAMP STATION.

in diameter, one connected to the water pipe and the other to a shaft of copper sunk in the tailrace.

The principal line of feeders is 30 km. (18 miles) long, and consists of six wires, each 7 millimeters in diameter, supported by metal poles common to the Societe de Force et Lenniere Grenoble et the Societe Hydroelectrique de Fure et Morge.

Current at 26,000 volts is distributed to the sub-stations, of which there are eleven. These sub-stations lower the voltage to 2000 volts, or 1000 volts, according to the locality. From these sub-stations secondary lines serve the stations of the subscribers. Certain industries use current directly at 2000 volts, but the majority prefer to lower the voltage to 120 by means of transformers furnished by the company. All of the stations are constructed in the same way, and consist of small Kiosks of masonry 3 meters square, in general surmounted by a tower which serves for the entrance of the primary lines and the exit of the secondary lines. The primary lines terminate at an air switch, then pass to a set of lightning arresters of the horn type, before entering the tower. The wires are then fixed to the terminals of a set of circuit-breakers similar to those of the generating station, and placed in niches of white marble. The secondary lines passing from the transformers are connected to a set of Wurtz lightning arresters, then to a set of circuit-breakers of the fusible type; and pass to the stations which they are called upon to serve from the tower.

The total efficiency of the station after a transmission of about 50 km. (31 miles) and a double transformation is 58 per cent. The Champ station is only intended to furnish electrical energy for motive power to the diverse industries installed principally in the valleys of the Fure and the Morge rivers. The rates for each h.p.-year are 125 francs ($25) per horse-power for a 12-hour day, and 150 francs ($30) for a 24-hour day load. The Societe Hydroelectrique has used a capital of 5,000,000 francs ($1,000,000) for this installation. The company has not made any lighting installations, as the districts traversed by its lines are already supplied by other enterprises for distributing electrical energy.

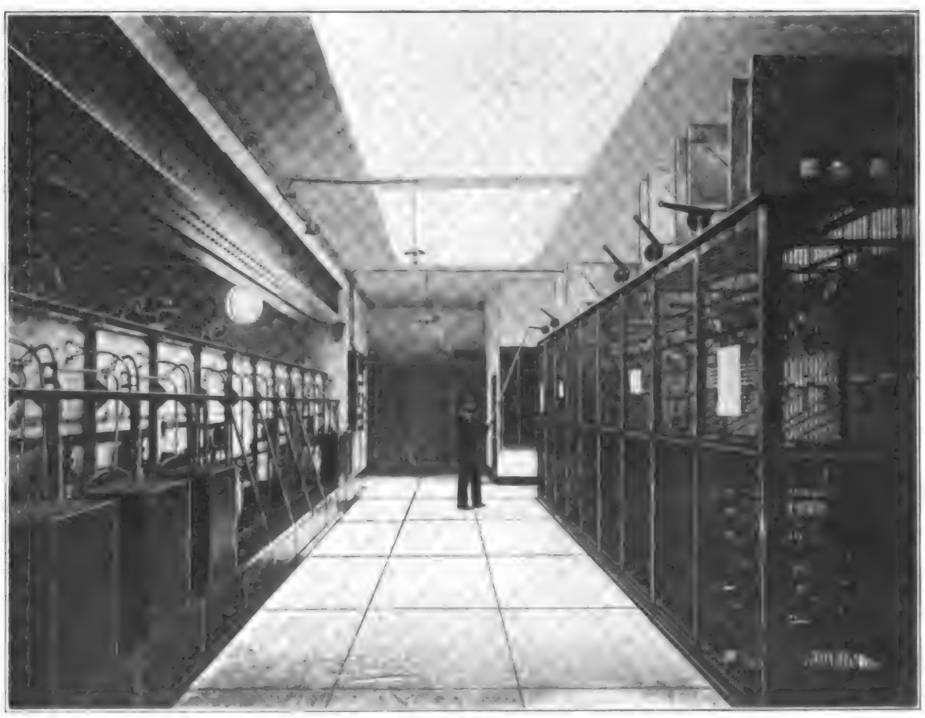

FIG. 4.—HIGH-TENSION SWITCHBOARD IN CHAMP STATION.

BOILER MANHOLES AND HANDHOLES.

BY R. T. STROHM.

Every steam boiler must be subjected to periodical cleanings, both inside. and outside in order to maintain its proper condition with regard to safety and efficiency of operation. For internal inspection and cleaning, some means of access to the inside of the boiler shell or drum is necessary. Consequently, boilers are fitted with manholes and handholes.

The location of manholes in a boiler shell should be such as to afford easy access to those parts requiring care and attention. In the plain cylindrical boiler, the manhole is placed in the head, which is usually bumped to make it self-supporting. In the return tubular boiler, there are usually two manholes, one being placed in the front head, below the tubes, and the other in the middle plate of the shell above the tubes and at the highest point of the shell. The lower one enables the inspector to examine the plates that are in contact with the furnace gases in operation, while the upper one permits him to inspect the condition of the braces and stays. In the case of water-tube boilers, a manhole is placed in the head of the steam drum, or in the head of each, if there are several drums. In boilers of the vertical type, the manhole is placed in the side of the central main drum, near the bottom, as in the "porcupine" boiler; or it may be omitted altogether, as in various other makes in which there is no necessity of entering to make examination of the condition of the shell; or in which the steam space or the water space are not large enough to admit a man. Handholes should be placed wherever deposits of sediment are likely to occur, if

these deposits cannot be easily removed through the nearest manhole. They are located in the water legs of vertical and locomotive boilers, in the heads of return-tubular boilers, and in the headers of water-tube boilers, opposite the ends of the water tubes, to which they give access.

The size of the manhole varies a little among manufacturers of boilers, but the average size is about 12 inches by 15 inches, the hole being elliptical in shape. Handholes are also elliptical, but they vary in size to a much greater extent than manholes. Thus, handholes may be found 9 inches by 14 inches, or 8 inches by 12 inches, and down to the common opening 4 inches by 6 inches, depending upon the size of the boiler and the location of the hole. The handholes opposite the ends of water-tubes in water-tube boilers are generally circular, especially when each tube has its own individual handhole. In case one hole gives access to two tubes, it is made oblong.

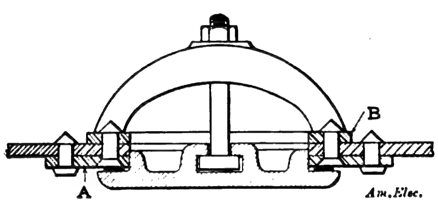

FIG. 1.

The cutting out of a section of the shell to give the manhole opening weakens the boiler, since it takes away a portion of the plate which would otherwise aid in resisting the forces set up by the internal pressure. Now, there is a greater pressure per inch of longitudinal seam than per inch of girth seam. That is, the boiler is more liable to rupture by splitting in a longitudinal direction than by tearing apart circumferentially. Hence, it is desirable to remove from the shell as little as possible of the metal which would strengthen the boiler along the line of greatest stress. For this reason, the manhole opening is so placed that its shorter axis or dimension is parallel to the longitudinal axis of the boiler, as in this position the shell is weakened least.

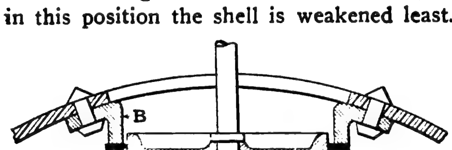

FIG. 2.

In case the manhole is placed in one of the heads its longer axis is horizontal, in order to enable a man to enter easily and not because the head is stronger with the hole in this position than it would be with the longer axis vertical.

To compensate for the loss of strength due to the cutting away of the plate, it is customary to use re-inforcing rings or their equivalent. The re-inforcing ring is simply a flat ring of metal riveted to the shell around the edge of the opening. The net section of this ring is made of such extent that its tensile strength will be at least equal to the tensile strength of that part of the plate cut away along the short axis.

The re-inforcing ring may be made of gun metal, wrought iron, cast iron or steel. The use of cast iron is not to be commended, however, for this ring must safely withstand stresses which tend to tear it into halves, and in tension cast-iron is a very unreliable and treacherous material. An ordinary form of re-inforcing ring, made of wrought iron, is shown at *A*, in Fig. 1. It is riveted to the inside of the shell by a double row of rivets, the row next the edge of the hole being countersunk so as to give a flat surface upon which the gasket may rest. Frequently an additional ring is used on the outside, as at *B*. In case two rings are used, their combined strength should be equal to or greater than that of the plate section removed.

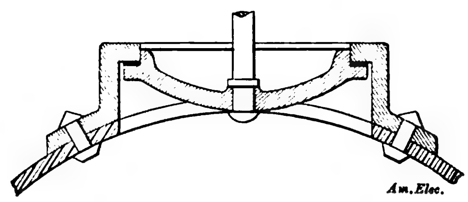

FIG. 3.

If a cast-iron frame or ring is used, it may have the form shown in Fig. 2, where the ring is shown placed on the inside of the shell. When the boiler is under pressure, the manhole cover, *A*, is pressed outward against the lip *B*, putting a compressive stress on the frame. Cast iron being very strong in compression, this is the safest form of frame made of this material. The fact that it is in tension laterally is the objection to its use. Another form of cast-iron frame but riveted to the outside of the shell, is illustrated in Fig. 3. In this style the metal is in tension in both directions; hence, the outside cast-iron frame should be avoided as far as possible. In a number of instances, outside frames of this shape are made of gun metal or wrought steel, these materials being amply strong in tension. Another method of re-inforcing manhole openings which is widely used is illustrated in Fig. 4. It is done by cutting the hole in the plate considerably smaller than the finished opening desired, and then flanging the edge, turning the plate inward, as at *A*, after which the edge is faced off nicely to form a bearing for the manhole cover. The ring of plate thus curved inward is relied upon to strengthen the plate properly.

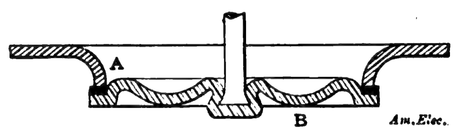

FIG. 4.

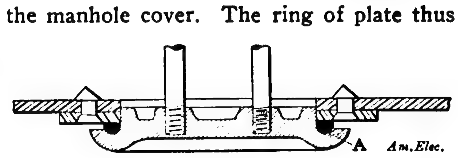

FIG. 5.

Usually handholes are comparatively small in size, and for that reason no re-inforcing ring is used in many cases, the handhole plate bearing directly against the plate. In the case of very high pressures, or very large handholes a single ring may be riveted outside the plate to compensate for the loss of strength due to the removal of material.

The covers of manholes and handholes are generally made of cast-iron, and they are held in place by the internal pressure when the boiler is under steam. However, it is necessary to have some means of securing them under all conditions, and so each plate is fitted with one or two bolts and yokes. These may be stud bolts, screwed into the cover, as in Fig. 5, or the plate may be drilled and the bolt riveted in place, as in Fig. 2. Another method, quite as common as either of the foregoing, is to cast the cover plate with a slot into which the head of the bolt is slipped, as illustrated in Fig. 1.

A form of cover plate which may be made either of wrought iron or steel is illustrated at *B* in Fig. 4. It consists of a piece of sheet metal which is formed to the desired shape by dies, under heavy pressure. The bolt fits into the dovetail slot at the middle, and cannot be pulled out by any ordinary force. This style of cover is very light, and as it is made of rolled material, there is little chance of flaws being present, which cannot be said of a cast-iron plate. The corrugations act as strengthening ribs, preventing buckling of the cover when under pressure.

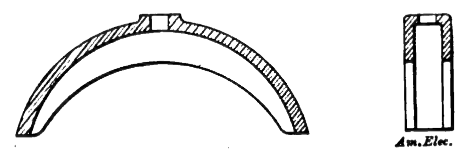

FIG. 6.

The yokes by which cover plates are held in place are made of cast-iron, to a great extent. In case the cover is of the form shown in Fig. 4, however, the yoke is made of the same material, being of the shape shown in Fig. 6; like the cover, it is formed by dies from a piece of flat plate. Where handholes are not re-inforced, it is not uncommon to find the yoke made so as to bear along the entire perimeter of the hole, as illustrated by Fig. 7, instead of at several points. as in the case of the ordinary yoke.

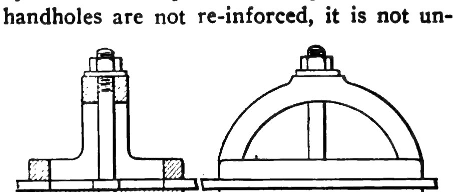

FIG. 7.

An ordinary cast-iron manhole cover has considerable weight, and it is no easy matter to hold it in place, and at the same time adjust the yokes and the bolts. To aid in placing it, wrought-iron loops or handles are frequently cast in the plate, by which it may be held and adjusted; the shape and location of these rings is usually as shown at *A*, *A*, in Fig. 8. The comparative lightness of the plate shown in Fig. 4 makes it unnecessary to provide any handles, which

is another advantage possessed by this type of cover.

Although the total steam pressure on a manhole or handhole cover plate is considerable, it is not sufficient to maintain a tight joint between the cover and the main shell.

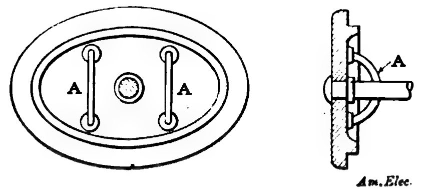

FIG. 8.

To prevent leakage here, gaskets of various materials are used. In Fig. 5 is shown the method of applying the gasket to the form of joint there indicated. A shallow recess is cast in the cover plate, into which is fitted a ring of gasket material of circular cross-section. When the yokes are put in place and the nuts tightened, the cover is drawn up against the re-inforcing ring, flattening the gasket as at *A* and making a tight joint.

A form of gasket widely used for this purpose is shown in Fig. 9. It is practically a heavy cord, made up of alternate layers of cotton duck and rubber, with a core of soft wire. It is sold in long coils, from which a sufficient length is cut when

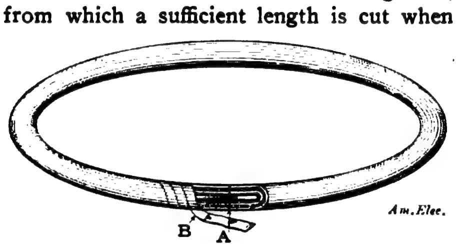

FIG. 9.

a joint is to be made. This piece is bent to fit the manhole plate, then its ends are cut so as to match nicely, as at *A*, and the joint is wound with tape, as at *B*, making a continuous gasket. Another style of gasket of somewhat similar construction consists of a small tube of Para rubber containing an insertion of brass wire gauze. This combination is encased in another layer of ordinary gasket rubber. Instead of wrapping the joined ends with tape, however, a short annealed copper sleeve or ferrule is employed, into which the ends

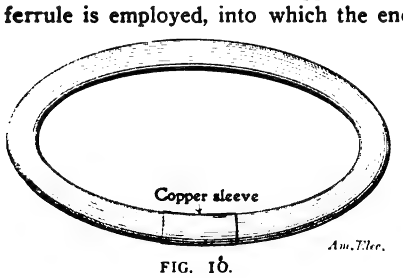

FIG. 16.

of the piece are forced until they meet, making the joint appear as in Fig. 10. The material for these gaskets varies from 3/8 inch to 5/8 inch for handholes and manholes, and may be obtained as large as 1 inch in diameter for extra large joints.

In case the flange of the plate or that of the re-inforcing ring extends inward, as in Figs. 2 and 4, to form a bearing for the cover, there is some danger of squeezing out the gasket. A form designed to prevent this action is illustrated in Fig. 11. It consists of two flat rings of rubber, *A, A*, between which is a soft metal ring of I section. The lugs on the metal ring pre-

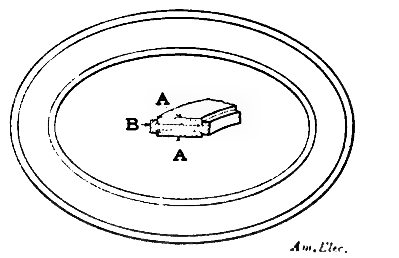

FIG. 11.

vent the rubber from being squeezed out entirely when the gasket is under pressure. The usual type of gasket, such as is used in connection with the manhole covers shown in Figs. 1, 2 and 3, is made of asbestos, rubber, rubber and copper, or metal alone.

If so desired, the cover plate may be made as shown in Fig. 12. A groove is cast in the flange, into which soft metal is poured and hammered. Owing to its plastic nature, this metal forms a good joint when the cover is properly drawn up, while the depth of the groove which holds it prevents its being squeezed out or blown out by the steam pressure.

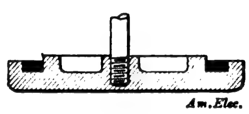

FIG. 12.

In most boilers, it is necessary to remove and replace the handholes and manholes frequently, and therefore the gaskets should be of such form as not to be easily destroyed by repeated breaking of the joints. It is well to give the gasket a coat of oil and graphite after it is put in place on the cover, so that when the joint is broken the gasket will not stick to the boiler shell. In replacing the cover, care should be taken to put it back in the same position that it occupied before it was removed, so that the same surfaces meet, in order to prevent leakage.

THE "PHANTOM" TELEPHONE CIRCUIT.

JAMES S. ROBINSON.

It is customary, between telephone exchanges having considerable toll business, to have order wires for the switching operators. When the distance is great, a special circuit called the "phantom" is sometimes used. This circuit should only be put on the best lines, as the least difference in balance will cause the phantom to be very noisy.

Fig. 1 herewith is almost self-explanatory. Repeating coils are placed in trunks 1 and 2, and taps are taken out of the middle of the line side of each. These taps are connected to one-half of the secondary of the double-wound induction coil and compound receiver.

The double wound head 'phone is connected to two plugs which go in the jacks marked *R*. It will be noted that one winding of the receiver is in the phantom circuit at all times. The distant operator has only to press her button switch marked *B* in order to carry on a conversation.

The switch, *B*, is shown in its normal position. The transmitter is then connected to the regular primary winding, the secondary of which is connected to the keyboard. Pressing switch, *B*, throws the transmitter on the primary winding of the special circuit and the operator can converse over the phantom.

Ring down phantoms are used in practically the same manner. It is not necessary, however, to have the special double induction coils and receivers, as the phantom is carried to jacks and drops on the board. When the phantom is not in use, the

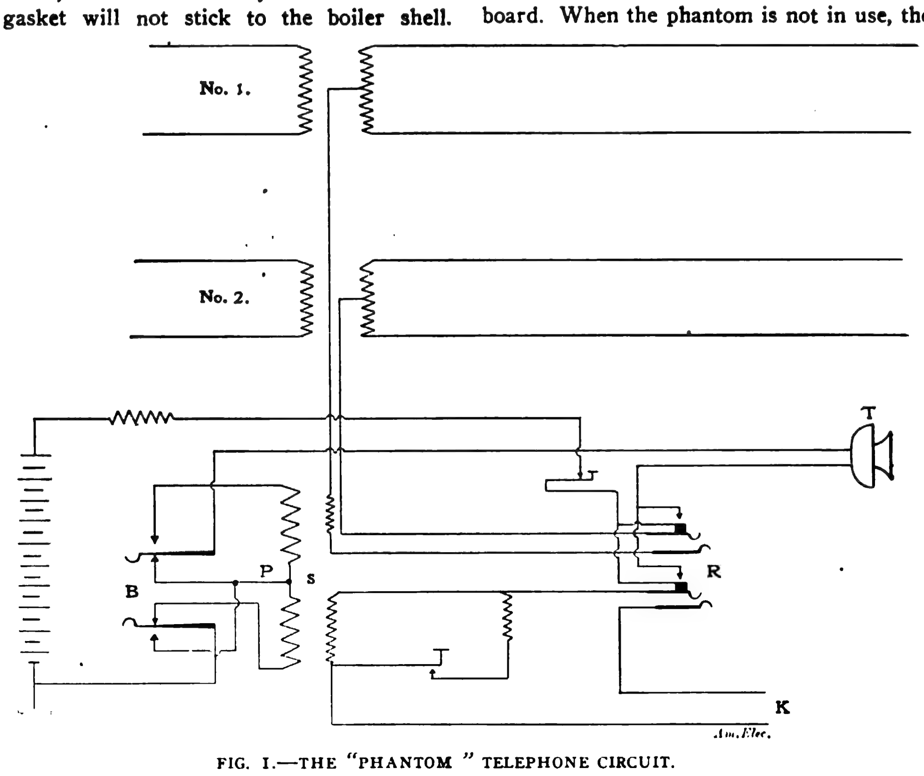

FIG. 1.—THE "PHANTOM" TELEPHONE CIRCUIT.

coils are cut out and the trunks cut straight through in the ordinary manner.

The installation of the phantom circuit does not entail any great expenditure, and the up-keep is practically nil.

THE MOTOR EQUIPMENT OF EXISTING MACHINE TOOLS.

BY GEORGE T. HANCHETT.

When a machine tool and an electric motor are designed together, well known principles of machine design can be applied and a uniformly satisfactory result is usually produced. Occasionally, however, the equipment of belt-driven machine shops presents itself, and the practice that it is wise to follow in such cases sometimes differs materially, since many considerations enter to influence the design. Briefly, the problem is to select a standard size of motor and then decide upon means of mechanical connection to the tool to be driven.

As a major premise it is assumed that rigid mechanical connections are the only ones to be considered. In the opinion of the writer one of the principal advantages of direct electric driving in machine tool work is that when electrically equipped the tool can be forced far beyond its belt capacity. This advantage is sacrificed when a belt connects the motor and the tool. Labor is far more valuable than kilowatt-hours, and this makes it expedient to resort to individual drive, when from a point of power economy, group driving might be preferable. Furthermore, the possibilities of economical shop arrangement for maximum production are favored materially by individual motor drive, and it is unquestionably wise to carry this method to a further degree than power considerations alone would suggest. Hence, the present article deals with cases of individual drive and geared connections.

Before selecting the motors and designing the parts the following data of the machine tool should be secured: Maximum speed of the driving pulley; minimum speed of driving pulley; diameter and face of largest driving pulley. This suffices to determine the power of the motor. The datum for the mechanical application consists of an accurate drawing of the entourage of the driving pulley. Full details should be included, for when the motor is selected and the drawings of the brackets are begun, it will be found that there are many things which interfere, and quite as many more of which important advantage can be taken.

The selection of the motor is, of course, of vital importance. Its speed should be high, at least 1100 r.p.m. or 1200 r.p.m., for if lower speeds are adopted the motor is bulky and unduly expensive, and its application becomes more difficult. The motor should have at least torque enough to skid the belt, and sufficient speed to drive the pulley at its maximum velocity. This fixes its minimum power. Further increase in the power of the motor depends upon practical considerations, which will presently be discussed.

The skidding pull on a single belt may be taken at 30 pounds per inch of width. A double belt may be credited with a pull of 60 pounds per inch. These are large values and are only true if the belt has a firm grip on a pulley of large diameter, and is well dressed, free from oil or grease and pulls evenly. As these latter conditions almost invariably prevail to a greater or less extent, a motor based on these figures will always outdo a belt by a comfortable margin. The method of calculation differs with the type of control to be employed, of which there are two great classes, armature control and field control. With armature control the armature voltage is varied by means of a multiple-voltage system, armature resistance, or other expedient. A third class of control is the mechanical, which is often worthy of consideration in the case of a constant-speed motor, the variable operating speeds being obtained by means of mechanical gearing or belting.

In order to discuss these methods intelligently, it is best to select a standard problem which will illustrate them. Suppose one has to deal with an engine lathe of which the following is the data:

Maximum speed of driving cone . .	200 r.p.m.
Minimum speed of driving cone	33⅓ r.p.m.
Diameter of largest driving cone	1.5 ft.
Width of double belt	4 ins.

The following formula will be useful:

$$H.p. = \frac{\textit{Belt pull} \times \pi \times \textit{Diam.} \times \textit{Max. speed}}{33{,}000}$$

In the present case the result will be:

$$H.p. = \frac{240 \times 3.1416 \times 1.5 \times 200}{33{,}000} = 6.8544$$

To adopt this size of motor would be to assume that the manufacturer of the machine had designed the cone to produce by belt pull sufficient power to bring the various parts of the machine up to their safe working stresses. It frequently happens, however, that a machine is inadequately belted, and that the tool is capable of using more power than the belt can provide. It is not, however, wise to overpower the tool, for it may be safely assumed that whenever this is the case the tool will be forced to the limit, and power sufficient to rack the machine to pieces should, of course, be avoided. However, a lathe equipped as above will at its lowest speed do better than when belt-driven, and on the highest speeds the improvement will be very great, for by armature control the power increases with the speed, whereas by belt control due to the reduced diameter of the pulley belt adhesion is not as good and power decreases with the speed. Therefore, the foregoing formula is usually applicable in cases where the speed is controlled by varying the armature voltage.

If the speed is to be controlled by varying the field, the power of the motor is definitely fixed and the results are influenced by different conditions. In such a motor the horse-power is constant and the torque varies; being a maximum at the lowest speed of the motor. In fact, such a motor duplicates the performance of the belt, as it is stepped from cone to cone, so that theoretically field control is a very beautiful and attractive means of solving the variable-speed problem. The formula in this case becomes:

$$H.p. = \frac{\textit{Belt pull} \times \pi \times \textit{Diam.} \times \textit{Min. speed}}{33{,}000}$$

and in the foregoing problem

$$H.p. = \frac{240 \times 3.1416 \times 1.5 \times 33\tfrac{1}{3}}{33{,}000} = 1.1424$$

This value, it will be noted, is exactly one-sixth of the value obtained by the armature control system, and is the power exerted by the larger motor on its lowest armature voltage, which would, of course, be one-sixth of its maximum voltage, sufficient to skid the belt at the lowest speed. It is, however, to be noted that this motor must possess peculiar characteristics. Its field must be so designed that it is capable of being weakened so that the motor will run without injurious sparking at a speed six-fold greater than it did before. This limitation on the design of the motor requires a field of considerable range, unusual precaution in commutator design, and other considerations, all of which compel the designer to make the motor more bulky, the result oftentimes being a machine quite as bulky and as expensive as the 6 horse-power competitor. Moreover, this machine does not increase its power with its speed as does the armature-controlled motor. Although it will do a little better than the belt on the high speeds, due to the defective action of the belt itself on higher speeds, the improvement will not be anywhere near as marked as in the case of the armature-controlled machine. Furthermore, in lathes and tools possessing back gears, the heavy cuts, the exhibition performance, at it were, are frequently made on the highest speeds with the back gears in, and when the engineer considers that he has, beside his own satisfaction, that of his client and of the machine operator to consider, both of whom are looking for great improvements, due to the outlay they have been compelled to make, it will be safer, should he adopt field control, to put a considerable margin on the power that this formula gives him.

Having selected the system, and, by the aid of the formulæ, computed the various sizes of motors which the many machines in the shop demand, a list of standard sizes must be consulted in order to select the machines themselves. This in itself is a commentary on the value of calculations to the fourth and fifth decimal place. A 6.854-h.p. motor is not a standard size, and even should one admit that this value is obtained through accurate theoretical assumptions, its accuracy in practical application is destroyed since one must use the nearest standard size. In this connection it is well to mention that the choice of size is done almost automatically, the engineer being irresistibly inclined to take the standard size of motor whose output is slightly greater than that found in the computation.

The problem must, however, be viewed as a whole, because the accumulation of a large number of different sizes in one shop

would be very unwise. The number of different sizes should be a minimum and all parts should be interchangeable, so that a minimum supply of reserve parts will protect the entire shop. For this reason it

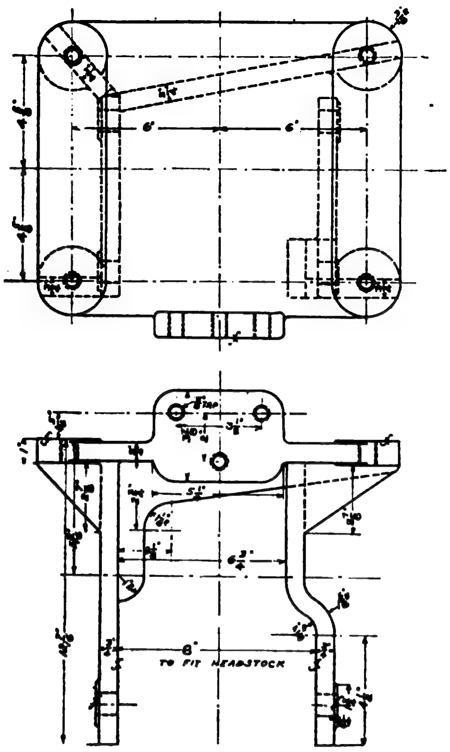

FIG. 1.

is often wise to select a 2-h.p. motor for a lathe which calculation indicates only needs 1½ horse-power, and it is sometimes wise to skimp the calculations a little in cases of lathes or tools which are occasionally used on light duty and adopt a size a shade lower, and thereby avoid an odd motor. It is here that good judgment must be displayed, and the previous duty of the tools must very largely influence the decisions.

Having selected the motors, their connection to the tools becomes the next consideration. In the opinion of the writer belting is only permissible in the case of small speed lathes where it would not pay to go to any expense, and where, moreover, the largest duty of the tool is done on the high speed, the belt adhesion being poor and advantage being taken of this by putting the belt on the largest cone.

The problem is one of machine design and no hard-and-fast rule can be laid down. The following remarks, however, may be helpful: The transmission must be first fixed upon. This must be either by gears or by the well-known forms of silent chain. Almost every machinist has had the trouble of having the lathe belt jam underneath the cone. Therefore, if the cone is to remain upon the lathe, a silent chain, unless abundant clearance is available, is inapplicable, and the problem is best solved by the application of gears. The motor should be supported on a bracket, preferably of cast iron, and the writer has found it convenient to employ idlers between the motor pinion and the gear which drives the lathe. A cup-shaped, toothed annulus, as shown in Fig. 1, may be conveniently employed and securely fastened to the cone by large screws. The width of the gears and pitch should, of course, be calculated with reference to the material of which they are made and the well-known torque formulæ. In designing the casting many troubles will be encountered. It is well to remember that the back gear shaft occupies a different position when the gears are out than when they are in. When the lathe is plentifully equipped with various gears for screw-cutting purposes or for driving feed rods, it may be found that while the casting will fit one combination of gears, another combination will interfere with it, so that the reserve stock of gears and their application to the machine should be carefully examined before finally deciding upon the dimensions of the casting. The writer has found it convenient to mount the idler bearing on a separate plate, which is bolted upon a finished plate on the main bracket, and which, when finally fixed in position, can be permanently secured with dowels. A few sixteenths for adjustment one way or the other should be allowed, for a founder's conscience with reference to dimensions is quite as warped as his production.

The speed of the gear teeth is an important problem, for even the best cut gears will be noisy if a certain speed is exceeded, and this speed seems to be about 750 ft. per minute. Beyond this speed it is wise to

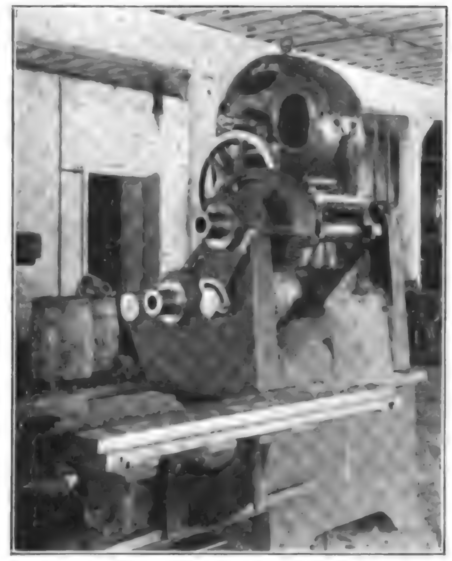

FIG. 3.

resort to rawhide gears, and the advantage of the idler becomes apparent, for a single rawhide idler will give noiseless contact between all of the gear surfaces. The application of the idler bearing to the main casting is shown in Fig. 1 and a lathe equipped in such a way is illustrated in Fig. 2. Frequent advantages are sometimes offered in lathes of peculiar design. In Fig. 3 is illustrated a lathe of the double-spindle variety, where the upper spindle was a serious obstacle to the mounting of the bracket. The obstacle was turned into a positive advantage by simply providing the bracket

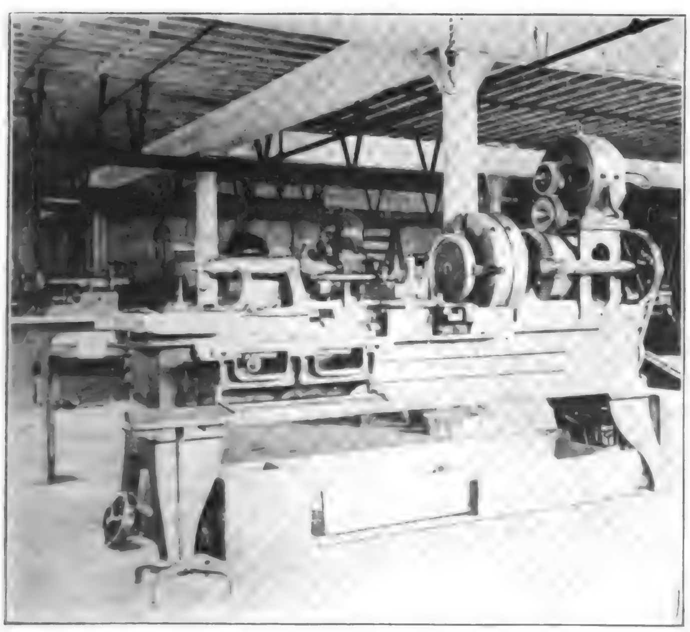

FIG. 2.

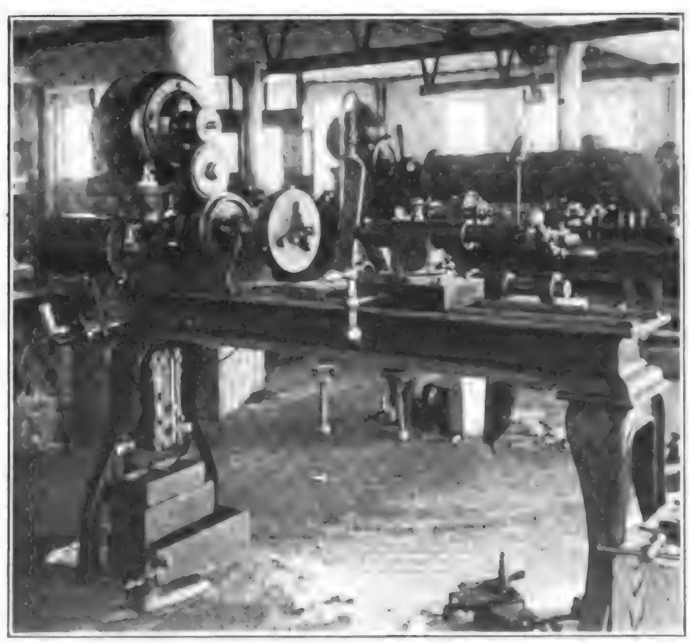

FIG. 4.

with bearings in a manner, somewhat after the fashion of suspending railway motors. The speed of the spindle was so low that the simplest lubricating device sufficed to keep the bearings cool. In the application of motors to brass lathes with special screw-cutting arrangements, which are more or less obstructive when motor driving is concerned, great care has to be

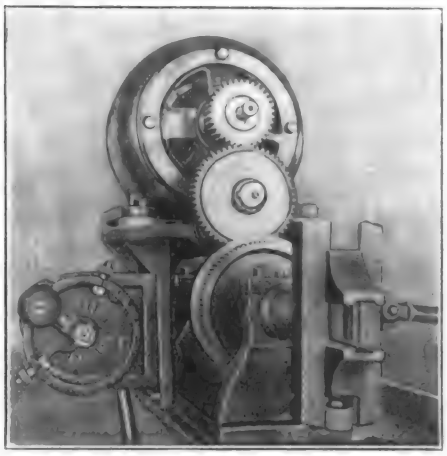

FIG. 5.

taken to avoid the gears and studs. With a case as shown in Figs. 4 and 5 it will be at once seen that to avoid the back and screw-cutting gears is a problem calling for ingenuity on the part of the draughtsman. In the application of brackets to lathes it will usually be found best to obtain the levels of the brackets by equipping their feet with small pins, which can be upset to any desired height with a few strokes of the hammer and lined up in the lathe bed. Once in line a bracket can be securely doweled and bolted to the head stock.

In applying motor drives to shapers, planers and millers, the problem is almost always a special one. Fig. 6 illustrates a Stockbridge shaper equipped with a motor and driven by means of a silent chain, the cone pulley having been removed for this purpose. Here abundant clearance was available and there was no danger of jamming the chain between the driving pulley and its surroundings, and the drive is a remarkably quiet one. In the case of milling machines and shapers, and planers which require two pulleys revolving in opposite directions, the problem is always special, and various solutions thereof are shown in Figs. 7 and 8.

A drill press illustrates a case of variable-speed from a constant-speed motor obtained by means of belts. To figure the power of the motor in this case the same formula that applies to field-controlled motors may be employed, but the resulting motor runs at constant power and speed, and therefore no extraordinary designs for wide speed variation need be employed, as that is accomplished by the belt. Care should only be taken to have the motor sufficiently powerful to skid the belt in its most adhesive combination. Any further power of the motor is superfluous.

The arrangement of the controller on the machine tool is also a matter which requires careful thought. It is perhaps one of the first things which the operator who uses the tool will criticise. The average "belt-driven machinist," if that term may be coined for the purpose, will, when transferred to a motor-driven tool, very frequently claw the air for an imaginary belt-shifter when the tap is about to the bottom or the thread tool is approaching the shoulder, and will usually succeed in breaking both tap and tool. The result is more or less forceful language and a general condemnation of the inconvenience of the system of control, and in order to reconcile and please him it is desirable to place the controller in a convenient place. In lathe work the writer has found it convenient and expedient in the case of short lathes to mount the controller on the bracket which supports the motor, as shown in Fig. 5. This is convenient for the machinist, provided that the lathe is not too long. In the case of long lathes the only place for the controller handle is on the apron. Various devices may be employed to bring it there. One of these is illustrated in Fig. 9, in which a splined rod runs under the apron parallel with the feed screw. The controller is placed at the end of the lathe and underneath it, and connection is made with the splined spindle by means of an ordinary bicycle chain, the ratio between the sprockets being so chosen that the angular motion of the lever for complete control of the motor is not too great. For a shaper, planer or drill press the controller position is of course fixed by circumstances, as these tools vary widely in their construction.

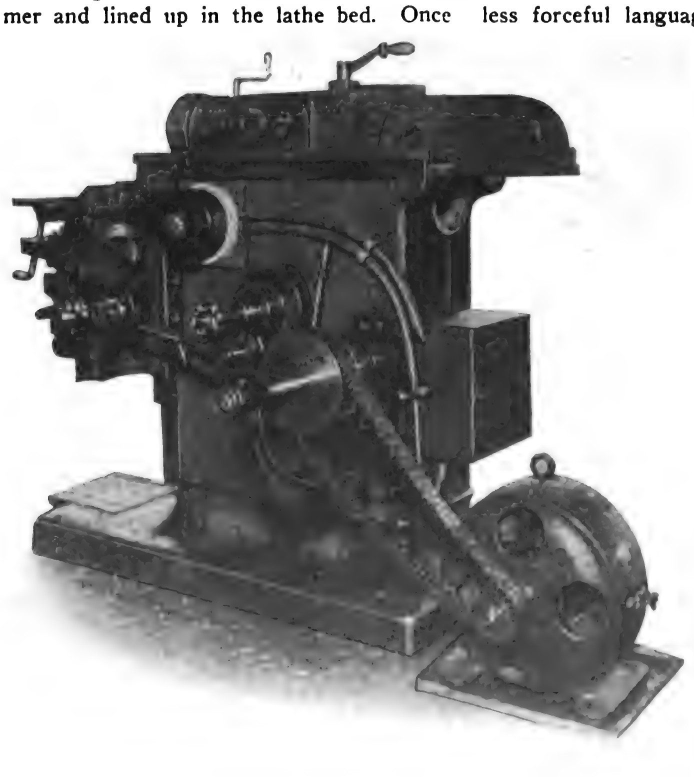

FIG. 6.

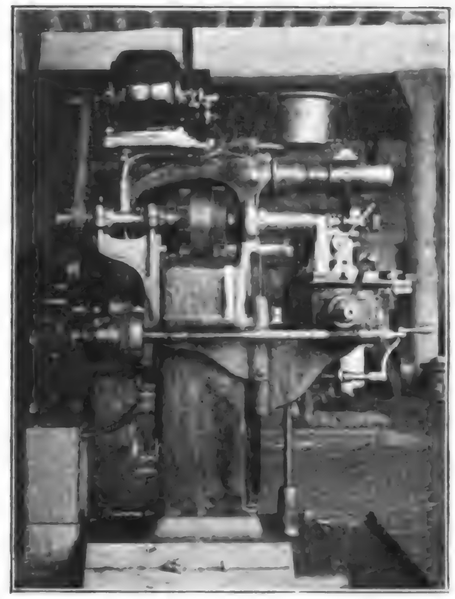

FIG. 7.

Figs. 6 and 7 illustrate methods which have been found convenient. In the case of tools which are used for steel work, particularly those for die making, the speed control must be very close. In the case of armature-controlled machines, the writer has found it convenient to equip them with rheostats which will provide a small amount of control by field variation. Almost any good standard motor will permit of enough variation by field control to bridge the gaps between notch and notch, and the combination, therefore, gives a very great number of speeds. It is, however, best to avoid this arrangement except in cases where it is absolutely necessary, for a machine tool, like a trolley car, should have as few unnecessary devices upon it as possible.

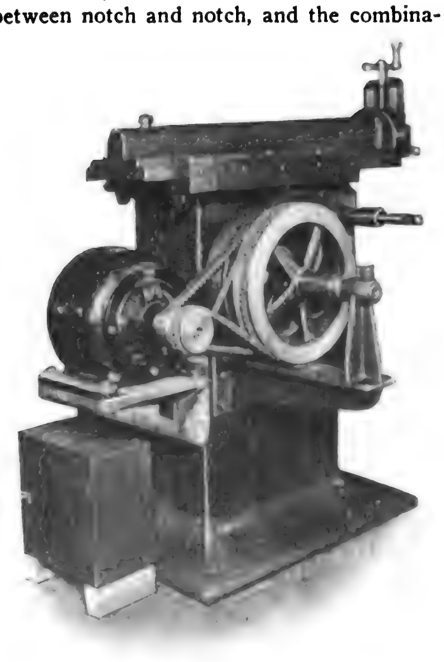

FIG. 8.

It is very difficult to educate the machinist to avoid starting a machine tool with a single motion, as in the old-time belt shifter fashion. It is a problem in human nature and not engineering. On a broad general principle the motors and the system of control should be selected so that the controller can be thrown to the desired speed in one swoop. For this reason it has been found convenient to equip the controller with stops so that the machinist can start his lathe by simply pushing his controller around as far as it will go. Such a system of stops is illustrated in Fig. 5, and has been found convenient for the machinist who, when he is busy with his work, has no time to select his speed, but simply pushes his controller handle one way or the other. This is of great convenience in thread cutting. Since machine tools are usually handled in this way, the writer is inclined to favor systems of armature-voltage control. Field-control systems, give trouble when brushes and commutator are neglected and vicious switching from full speed ahead to full speed reverse is practiced. In such cases

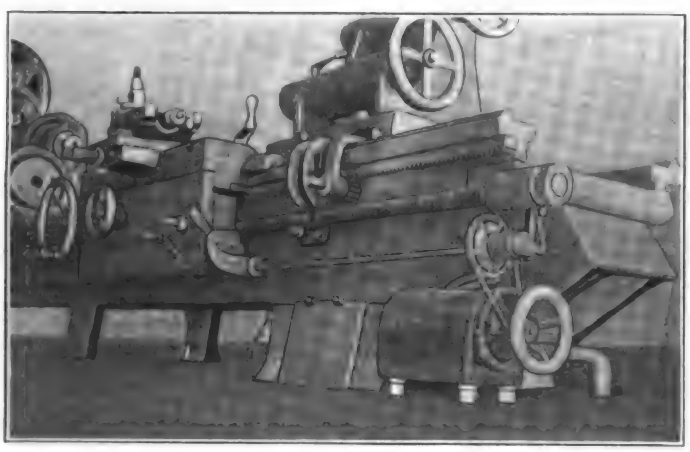

FIG. 9.

salvation from commutator pyrotechnics obtains in a field of maximum strength.

The application of circuit-breakers to machine tools is one on which there are many opinions and which deserves careful consideration. On heavy powered machine tools there is no question but what they are a useful check on unwise controller manipulation. In small machine tools, however, the writer has found a fuse of ample protection. A small motor will resist momentary surges of current much better than a large one, and as the motor has only intermittent work, the heating obtained through such flushes of current is not serious. Moreover, the losses in the variable-speed motor are never a maximum, for when the speed is high the I^2R loss is usually low, and in cases of armature control, when the speed is low, the iron losses are materially reduced. Therefore, an armature so arranged can stand much more punishment, and in small motors, fuses of 100 per cent. overload capacity are found very satisfactory.

The switch which controls the motor, should, in the opinion of the writer, be substantially boxed in. If it is exposed to flying metal in a machine shop there are too many opportunities for a short circuit.

AUTOMATIC BLOCK SIGNALS.

BY RALPH SCOTT.

Normal Clear Signal Mechanism.

A part elevation and part section of the mechanism employed in one form of the Union Signal is shown in Fig. 51. This mechanism consists of the motor *D*, which is geared by a small pinion to the large gear *W*, the latter being protected by a guard *V*. The pinion of this large gear engages with the smaller gear wheel *F*, which latter is mounted on a shaft that carries a small sprocket wheel, over which passes the chain *I*. The function of this chain will be shown later.

The signal boards are connected respectively to the rods *Q* and *S*. These rods are given motion by the pivoted members *E*, which carry electromagnets *U*. The cores and winding are shown in the sectional part at *G*. The armatures of these electromagnets are connected by links to the pivoted cam-shaped pieces *N*. The movement of the chain of levers which operates *N* also produces a number of other conditions which will be described later.

Dash pots, *D*, serve to check spasmodic movement of the arms, *E*, which latter are of a very heavy construction, and, consequently, require good damping means to prevent injury to the moving system. Mounted upon the same frame as these dash pots are the binding posts, *P*, which facilitate the various connections of the electrical devices employed in the signal mechanism. The motion of the piston of the dash pot which is connected to the home board, operates, by means of the lever, *C*, a current reverser, *J*.

This current reverser consists of a number of pivoted contact pieces rigidly connected to, but insulated from, the lever *H*. These contact pieces make connection with the flexible spring pieces *M*, which latter are connected to the binding posts *L*.

Upon the stationary bars *K* are mounted the insulated spring pieces *A*, which are brought into contact by an insulated piece *T*, carried upon a pivoted member *R*.

Another similar piece is also pivoted, and is operated by the distant members *E*. The purpose of these contacts is to make connection according to the position of the member which operates the board, as has already been shown in the circuit diagrams in Fig. 50.

A more detailed view of the mechanism which directily and indirectly causes the signal arms to assume their clear or danger position is shown in Fig. 52. Carried upon the chain *a* is a roller *e*, which engages with the pivoted member *i*. The

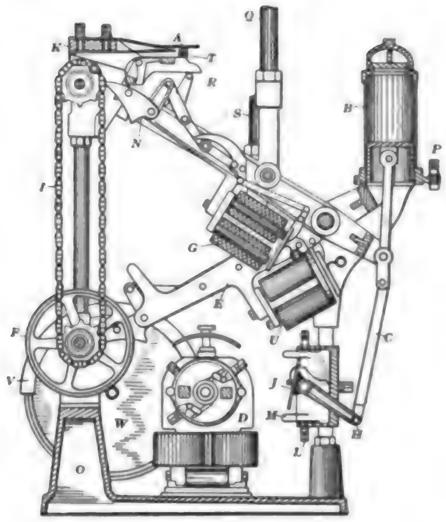

FIG. 51.

position of *i*, which is carried on the arm *m*, depends on the position of the armature of the relay *b*.

When current is passing through this relay, and its armature is attracted, the cam piece *h* moves the train of levers and throws *i* so that the end engages with the rollers *e*. If the chain *a* be moving it will,

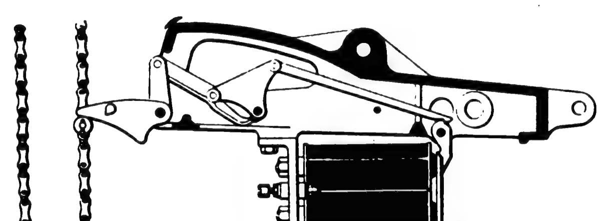

FIG. 53.

therefore, cause motion of the member and thereby moves the semaphore, which is connected to *j* by the rod *d*, the dash pot rod *g* preventing the motion from being too sudden. If, however, the relay is not energized, *e* will not engage with *i*, and thus prevent motion from being imparted to *d*, even though the signal motor be running.

Another form of this mechanism which

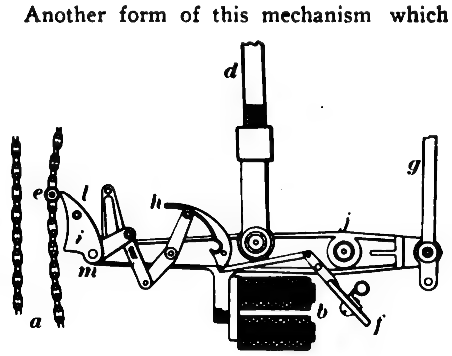

FIG. 52.

is much more reliable in its action and represents most up-to-date practice is shown in Figs. 53, 54 and 55. In Fig. 53 the relay is energized, and attracts its armature, which engages with the latch as shown. The moving chain causes the roller to come

into contact with the pivoted members, thereby throwing the signal to the clear position. If now the magnet be de-energized by the cessation of the track circuit current, the latter releases its hold, and,

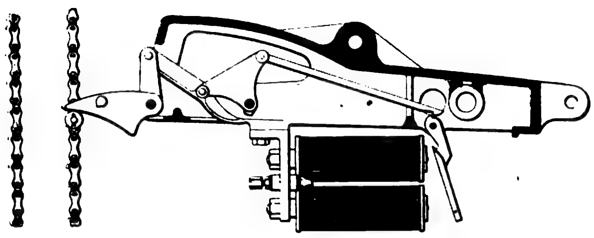

FIG. 54.

consequently, allows the signal to assume the danger position shown in Fig. 54.

The final position of the mechanism is shown in Fig. 55, the signal remaining in this position. After the roller has become disengaged with the cam piece the weight of the latter causes the latch bar to again engage with the relay armature. This engagement being, however, of sufficient resiliency to cause a disengagement when current is not passing through the relay on a further motion of the chain.

Normal Clear Relays.

In Fig. 56 is shown a neutral or slow-releasing relay, which is shown diagrammatically at *I* in Fig. 50. This relay is designed to secure a slow release of its armature after the energizing current has ceased. This relay is necessary, and must be included in series with the semaphore magnet or motor to prevent the opening of the signal circuit during a momentary reversal of current, which occurs on the movement of the polarized armature of the relay controlling the section to which the

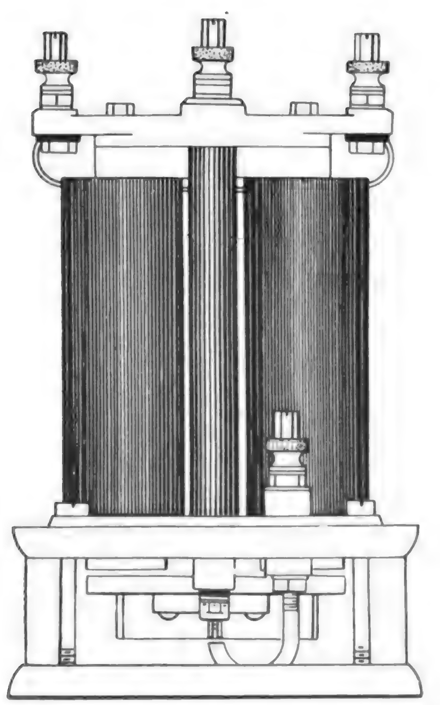

FIG. 56.

semaphore mechanism is connected, as is the case with the wireless track circuit system.

The slow release of the armature of this relay is effected by using a very long magnet core wound with a large number of turns of wire, thus giving a high self-induction, which prevents demagnetizing for a length of time sufficient to prevent the circuit being opened on the momentary reversal of current. With such a relay, a very high resistance is desirable, so that but a small magnetizing current is required. The residual magnetism, combined with that resulting on the inductive discharge,

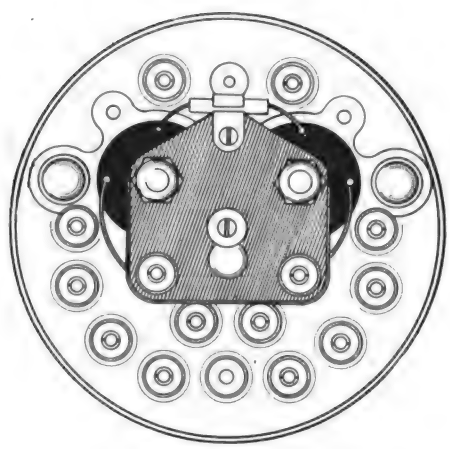

FIG. 57.

maintains the magnetism for a comparatively long interval of time.

A polarized relay is shown in various sections and elevations in Figs. 57, 58, 59 and 60.

Fig. 57 is a plan view, showing the arrangement of the binding posts for making the external connections.

Fig. 58 is a part elevation and part sec-

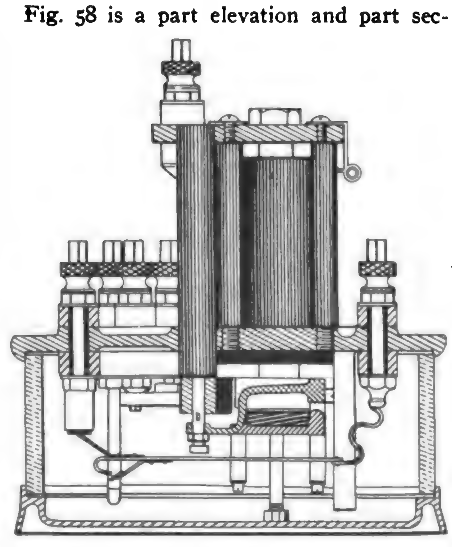

FIG. 58.

tion showing the arrangement and construction of the pivotal bearing for the polarized armature and the arrangement of the neutral armature and its contacts.

Fig. 59 is a view taken beneath the instrument showing the arrangement of the polarized armature *b* and the polar contacts *a*, which are mounted upon, but insulated from, the armature.

Fig. 60 is an inverted view which shows

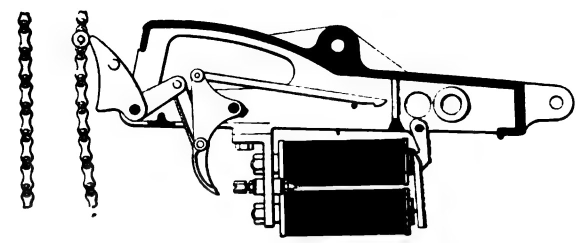

FIG. 55.

the arrangement of the neutral armature and contacts and also showing part of the polar contacts.

By referring to these illustrations, it will be noticed that the armature is pivoted very

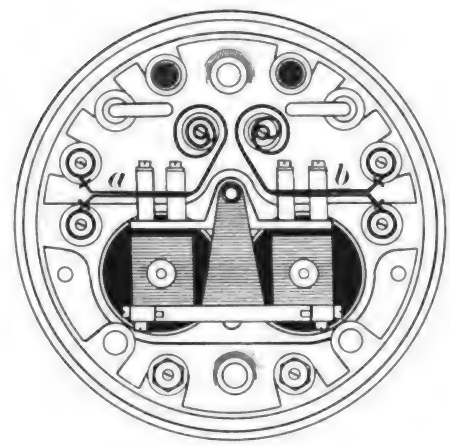

FIG. 59.

closely to the magnetic field, the contacts being at the end of comparatively long prongs, so that, while a very short stroke is given to the armature, a very wide opening to the contacts is given. The reason for this is to keep the armature itself within the range of a very strong field, as soon as the magnets are energized. The armature, however, is not too close to cause any evil effects from residual magnetism.

The armature pivots themselves are sup-

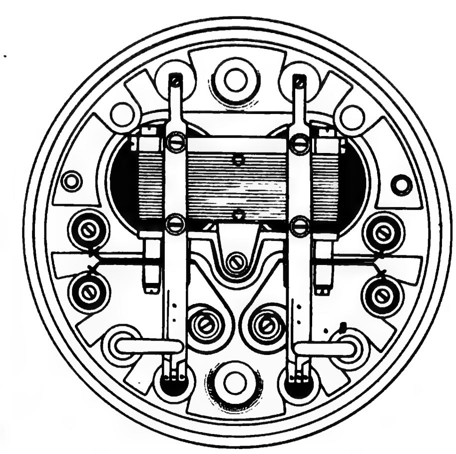

FIG. 60.

ported by the pole pieces, so that the armature is always kept the same distance from the poles, rendering unnecessary any further adjustment. The bearing of the polarized armature is comparatively large, which

prevents any binding action due to any uneven wear which may occur. The neutral armature is located below the polarized armature and in a plane perpendicular to that of the latter.

The contacts made by the polarized armatures have a scraping motion, which serves to keep them continually perfect. By noting the connections effected by the motion of this armature, which causes the contacts to shift alternately to the four contact posts, these contacts being connected to two stationary posts, the manner in which current reversal is effected will be readily perceived. The contact fingers of the short flexible contact spring are fastened to their free ends, the reason for this arrangement being a maximum amount of sliding with a minimum armature motion.

The contacts are of carbon and platinum, to prevent oxidation. The contact arms are connected to the binding posts by means of thin strips of copper, which have great flexibility, and prevent interference with the adjustment of the relay. All contacts and moving parts are enclosed in a glass compartment, to prevent accumulations of dust from effecting these contacts.

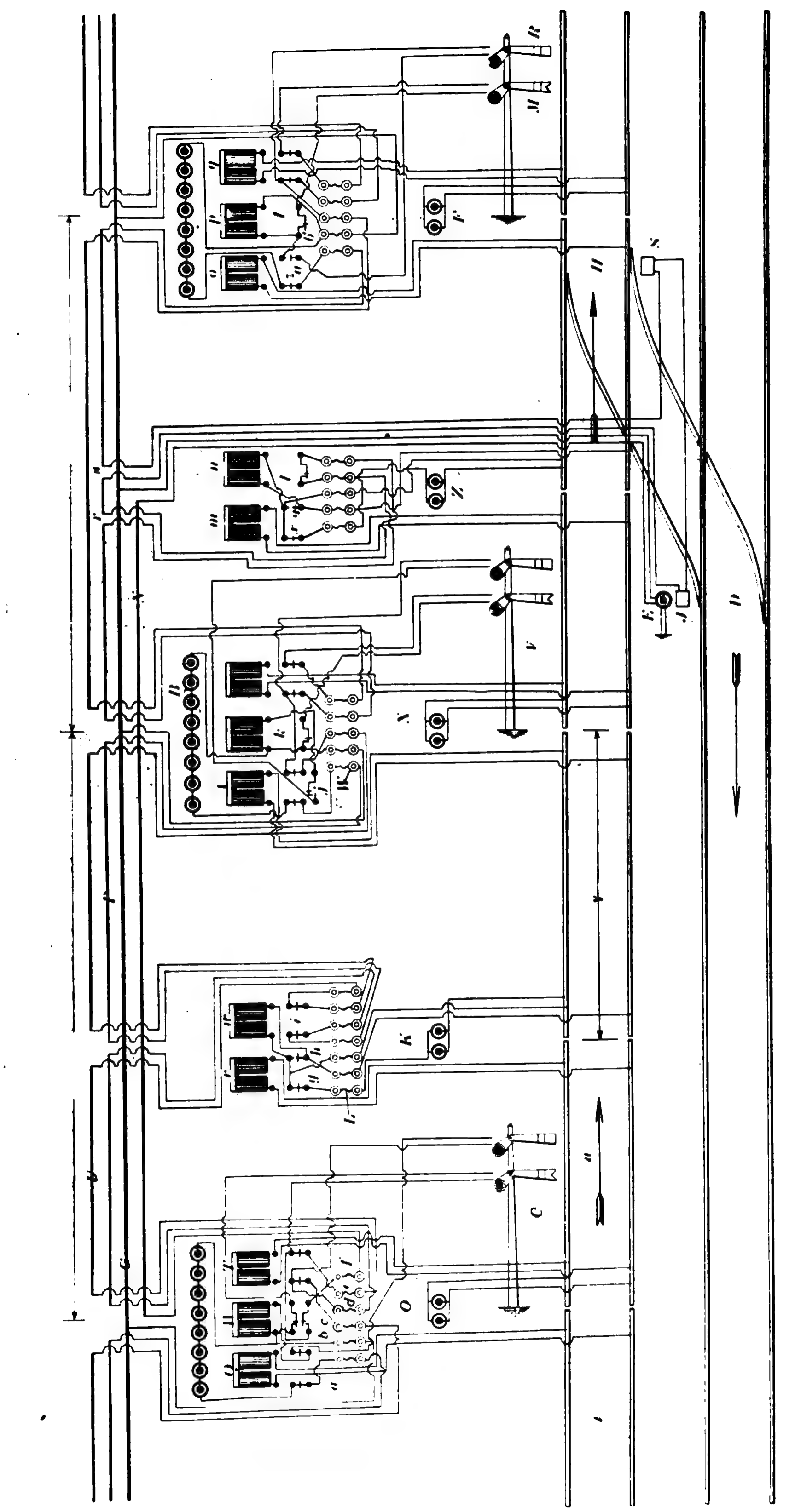

FIG. 61.—DIAGRAM OF COMPLETE NORMAL DANGER SYSTEM.

Complete Normal Danger Circuits.

Having now described the various forms of simple, normal, danger circuits giving protection against various occurrences, the description of a signal system which gives every protection that is possible for any system to give, namely, against an open rail, open switch, train in the block or defect in the signal apparatus, follows:

In Fig. 61 such a system is shown, line wire in this case being used. The distant wire which operates indirectly the distant board of all the signals is *U*. *P* is the home wire, *G* the common wire, and the indicator wire is *N*. *O, K, X, Z* and *F* represent, respectively, five cut sections which are each one-half mile apart, this distance being shown at *Y*.

The block of each of the signals *C* and *V* contains two cut sections, part of one of the sections of the signal *M* being also shown. On account of the different connections employed in each cut section it will be necessary to describe these specifically.

Beginning at section *O*, which is a signal section, there is the row of connecting posts *a, b, c, d* and *f*. *a* is connected to one side of the signal battery and also to the incoming home line wire. The connection to the signal battery is through a normally closed armature contact, which is opened when the relay *G* is de-energized, which will be the case when a train is upon section *t*. When this occurs, the first signal in the rear of *C* will be held in the danger position even though a train be approaching it.

The post *b* is connected to the common line wire, to one side of the block signal battery and to one side of the relay *W*. When the armature of the latter is in the upper position, this post is also connected to the distant board of the signal *C*.

The signal battery has thus one side connected to the common wire. This is the case with every signal, as will be evident from an inspection of the posts at *V* and *M*. Post *c* is connected directly to the home board *C*, to the post *d*, through one of the armature contacts of the relay *t*, and to the incoming home wire.

Post *e* is connected through the other armature contact of *T* to the distant board of *C*, to the lower normally opened contact of the relay *W*, and the outgoing distant wire. *f* is connected to the other side of the normally opened contact of *W* and to the indicator wire. *W* is energized by current passing in series with the other signal mechanism, operating the home board of the signal *C*. When this occurs, the battery becomes also connected to the distant board by the action of the upper armature contacts. The relay is consequently energized until the train occupies the section *u*. A train in this section will, it is also evident, short circuit the relay *v* in the relay section *K*.

The contact *g* on this relay's armature is normally closed while *h* is opened. When *h* is closed, the track section *Y* is short circuited. *g* serves the purpose of connecting the track battery *K* to the section *Y*. When this contact is open, the relay *A* at the signal section *X* is open. Thus, there is in this

combination essentially a track circuit system such as is shown in Fig. 37.

The normally closed contacts of the relay w are connected respectively in series with the home and distant line wires. Hence, when the battery K is not connected to the section U, or when the relay v is short circuited, the home and distant line wires will be broken. As will be seen, the contact h short circuits the relay w when closed. g and h, therefore, perform five functions, each of which is outlined above.

At L is shown, in diagrammatic form, the protection against high potential discharges or destructive foreign currents. This consists of choke coils and fuses.

At section X another signal, V, is shown. The signal battery V is connected to the first binding post W, the other side of this battery and the common line wire being connected to the second post. This section is similar in connections to section O except that the central relay has but one cross connected contact, K, which is normally closed. J connects one side of the signal battery to the central relay, and is normally open.

Section T is the relay section, and also contains two switch instruments and a switch indicator, these being placed at a main line crossover, the home line being broken at r and s, and in series with the various devices.

Relay m, through its contacts, x and y, controls the connections of battery z to the track. Contact l of the relay n virtually closes the home wire at r, and y in its operative position short circuits this relay. The indicator line wire N passes to the switch indicator E, the other side of this indicator connecting to the common line wire, this being connected to one side of all the signal batteries, the connection of the other side of these batteries depending on the interconnection effected by the various relays, within two signal blocks from the instrument.

It is to be remembered that when the signals within two blocks of the instrument are at danger, the switch instrument is at the clear position, that is, connected to the batteries. This indicates that a train may proceed from a siding to the main line without any danger of intercepting a through train. The series switch instruments J and S, it will be seen, open the home wire at both the east and westbound switches. This is the usual practice, and indicates danger to a train on either main line when either switch H or D is open, the connection for the other track line wires not being shown.

Signal section I is somewhat similar to the section O, with a number of extra connections. o and q are track relays connected respectively to the track batteries Z and F. The contacts c' are connected respectively to the signal boards M and R, the latter being also connected together, through the armature contacts a' and b'. z is in series with the signal battery and the distant line wire. It will be noted that all home signals are operated at the first block in the rear of the signal and all distant signals at the second block in the rear.

MUNICIPAL LIGHTING PLANT AT BLUFFTON, IND.

The following description of the electric lighting and power system owned and operated by the city of Bluffton, Ind., will afford an interesting study of the progressive inclination of many of the western cities.

Bluffton, the county seat of Wells County, Indiana, is situated about 25 miles south of Fort Wayne, Ind., on the Lake Erie and Western Railroad, and is in the midst of a rich agricultural, gas and oil-producing country. The city has a population of about 5000 people, has several miles of asphalt paved streets, elegant schools and public libraries, substantial brick and stone buildings throughout the business section.

A considerable number of the residence streets are provided with beautiful and costly dwellings, and the general appearance of the city is so pleasing in every way, due largely to the excellence with which the public affairs of the city are conducted, that its reputation and renown as the "Parlor City" of Indiana is well merited.

For many years Bluffton has owned its water works, consisting of two 1,000,000-gallon Holly compound pumping engines and a large cross-compound Ingersoll-Sergeant air compressor; and for several years past has operated in connection with the water works a series arc lighting plant for street lighting, consisting of two T. H. arc generators, driven by a 14 by 12 automatic engine.

Up to the winter of 1902-3 natural gas had existed in sufficient quantity to supply all local requirements for light and heat, but the supply of gas becoming gradually less, it was determined by the city in May, 1903, to build a modern plant to provide electricity for light and other purposes.

The power station, which includes the water works, is located in the eastern part of the city. The building is a handsome structure built of brick with slate roof and completely fireproof, divided into four sections; boiler room, pumping room, air compressor room and dynamo and engine room.

The engine room is 25 ft. high, 25 ft. wide and 36 ft. long, and is amply large for the machinery installed. The floor of the engine room is made of concrete and cement with a finished coat 2 ins. thick of granolithic marble, polished on the face. All foundations for engines, generators and exciters are built of concrete and cement.

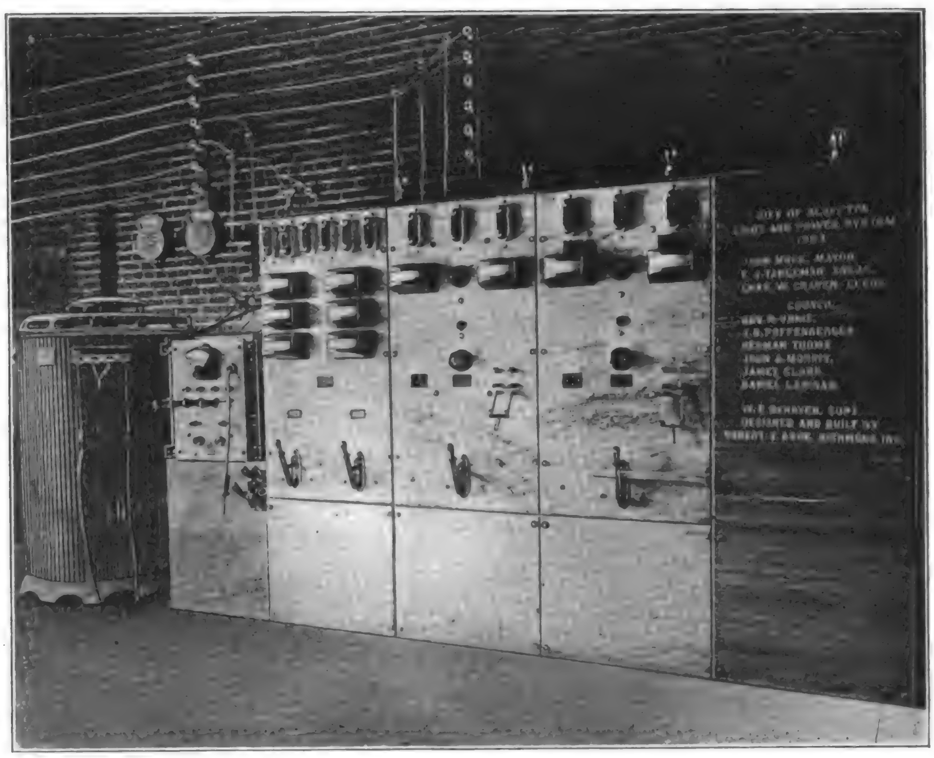

FIG. 1.—SWITCHBOARD IN THE BLUFFTON STATION.

The boiler equipment consists of four 125-h.p. boilers, built by the Bass Foundry and Machine Company, and arranged in two batteries.

The safe working pressure of these boilers is 120 lbs. Natural draft is supplied by two steel stacks 40 ins. in diameter and 100 ft. high, securely guyed by steel cables attached to posts well set in the ground.

The feed-water is passed through a heater made by the Steam Appliance Company, of Milwaukee, and is supplied with steam from the exhausts of the pumping machinery, air compressor and engines, the latter being by-passed to atmosphere through Burt exhaust heads.

Two Laidlaw-Dunn-Gordon duplex boiler feed-pumps are installed, each one being large enough to furnish all the feed-water required.

In the construction of the new electric

section of the power house, all of the old boiler headers and steam lines used in connection with the pumping machinery and old electric plant were removed and high-pressure flanged piping of the heaviest character was substituted in its place. The present steam header consists of a 14-in. pipe extending the full length of the boiler room. Each boiler is connected with a bend to the header, with a valve at each end of the bends. Connections for engines and pumping machinery is taken from the top of the header through easy bends and at all low points throughout the entire piping system, taps are installed for collecting the condensation and the water is returned through traps to the heater. Separators of the Milwaukee type are connected with suitable traps in all of the steam mains feeding the pumping and electric units. The complete piping work was installed by Woolen & Callon, of Indianapolis, Ind.

The electric lighting engines are of the vertical cross-compound type of unusual heavy construction throughout. The cylinder measurements of the large engine are 15 ins. and 26 ins. by 18 ins. stroke, and the smaller engine has cylinders 12 ins. and 20 ins. by 14 ins. stroke. These engines are of the direct-connected type, and were built by the Reeves Engine Company, of Trenton, N. J. The large engine has a normal capacity of 250 horse-power, and maximum of 476 horse-power; the smaller engine has a maximum capacity of 250 horse-power.

The engines are equipped with the Rites governor and a clever mechanical arrangement on the governor wheel whereby the pin supporting the governor is lubricated and shifted in its bearing with every action of the governor. The engines are also provided with adjustable steam-tight balanced piston valves, and the unusually compact form of construction together with the steam distribution employed has enabled a rather high degree of economy to be obtained in the operation of the engines.

Automatic oiling is employed throughout, no attention being required in this respect whatever beyond the filling of the oil reservoirs.

The generators are of the three-phase revolving-field type and develop 200 kilowatts and 100 kilowatts, respectively, the voltage being 2200 and the frequency 60 cycles. The speed of the large machine is 200 r.p.m., and of the small machine 257 r.p.m.

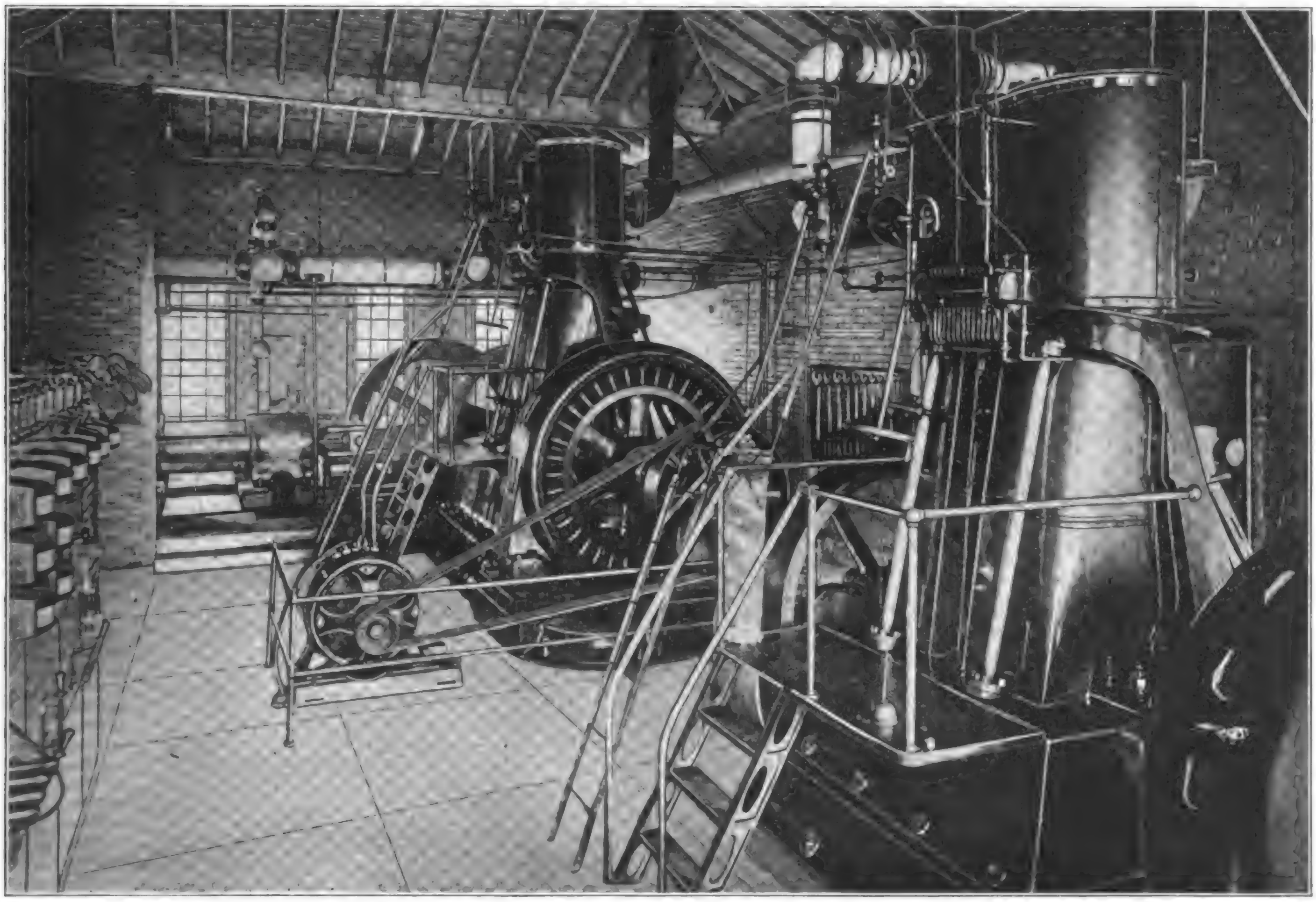

FIG. 2.—GENERATOR ROOM OF MUNICIPAL LIGHTING PLANT AT BLUFFTON, IND.

The exciters are two in number, each being driven by a belt from the end of the generator shaft. These exciters are of 11 kilowatts capacity each, and were made 50 per cent. larger than the requirements for excitation, so as to have a large factor of safety in this respect.

All lines from generators and exciters between the machines and switchboard are of rubber covered cables, drawn in American fibre conduits, waterproofed and concealed beneath the floor line. The switchboard is composed of four panels of blue Vermont marble 2 ins. thick by 30 ins. wide, and 90 ins. high, made by the General Electric Company, and completely equipped with its standard apparatus. Each of the generator phases has an ammeter of the dead beat horizontal type. Oil switches are used on all alternating-current circuits, and the usual equipment is provided for controlling the exciters. The board is also provided with voltmeters, synchronizing instruments and Thomson astatic ground detectors. On the rear of the board is installed, with floor supports, the generator field rheostats connected so as to be operated by insulated rubber handles on the front of the board.

Mounted on the brick wall in the rear of the switchboard are Thomson recording wattmeters, one connected in each of the generator circuits, which thus record the total output of each generator.

A 100-light series street lighting transformer is located in the engine room and supplies current for 80 G. E. enclosed arc lamps of the latest type. This portion of the equipment is controlled by an independent marble panel, of G. E. make.

The current for operating the street lighting service is taken from one of the phases, this phase being used exclusively for street lighting work.

All current is sold by meter, the price to the majority of customers being ten cents per kw.-hour. Wattmeters made by the Westinghouse Electric and Manufacturing Company are used. Transformers of various sizes are installed. These were provided by the Vindex Electric Company, of Aurora, Ill.

The city of Bluffton's plant began operation on March 24, 1903, and has continued in operation since, giving a day and night service with the best of satisfaction. At the time of starting the plant the connected load was 80 arc lamps and about 2500 incandescent lamps, and after six months of operation the incandescent load was more than doubled. All of the transmission lines from power house to centers of distribution are three-phase. Two of the phases being tapped at these points by single-phase lines, which feed into the transformers arranged with three-wire secondaries at 104 and 208 volts. All pole lines are substantially built of 30-ft., 35-ft. and 40-ft. poles, the location of all pole lines being in the alleys, no poles being allowed in the streets.

The design and construction of the entire work was entrusted to Robert S. Ashe, of Richmond, Ind.

DIRECT-CURRENT DISTANCE SWITCHES.

BY OUR BERLIN CORRESPONDENT.

Occasionally cases arise where it is desirable to switch in certain current consuming devices, such as, for instance, a group of lamps from a distance. The situation of the devices may be such that they cannot be seen from the switching place, so that a switch to be of best service should indicate whether or not the distant circuit has been completed. The device shown by Fig. 3 herewith fulfills these re-

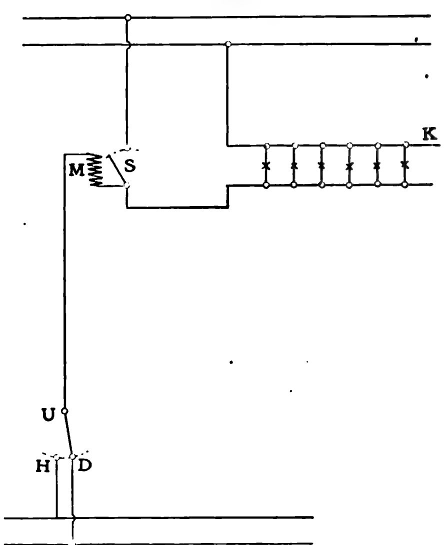

FIG. 1.

quirements in a very simple way, one small feeder being used exclusively, so that there is no occasion to resort to polarized armatures or other complicated elements.

The working of the apparatus may be made clear by reference to the diagrammatic sketches shown by Figs. 1 and 2; one being applicable to a two-wire system, and the other to the three-wire system. In the sketches, *K*, represents the distant current consuming devices that are to be placed in circuit, *S* is a lever serving to establish the connection with the circuit, the lever being under the influence of the electromagnet, *M*. One terminal of the magnet winding is connected to the distant circuit *K*, and the other terminal to the switch, *U*, at the switching place by means of the small feeder wire.

When it is desired to switch in the devices at *K*, the switch lever is placed on the contact, *H*. Current from the positive distribution bar will then pass through the coils of the electromagnet and the lamp to the negative pole of the distribution system, exciting the magnet, *M*, which in turn will cause the switch, *S*, to be closed. As soon

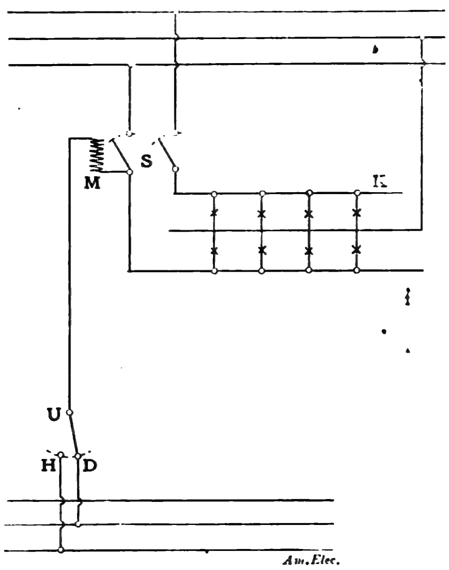

FIG. 2.

as the circuit at *K* is completed both terminals of the electromagnet are at the same

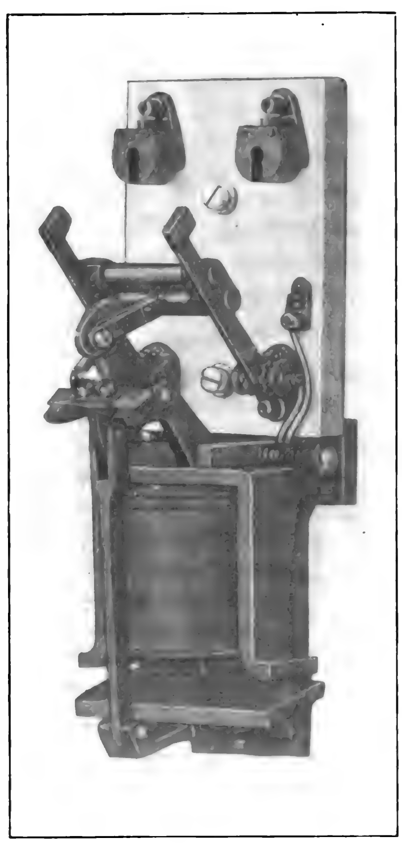

FIG. 3.—REMOTE-CONTROL SWITCH OPEN.

potential so that no current flows through the winding. In order to disconnect the devices at *K* from the circuit, the switch, *U*, is placed on the contact, *D*. The magnet winding will then be subject to the full potential of the distribution system, and the lever of the switch, *F*, is attracted into

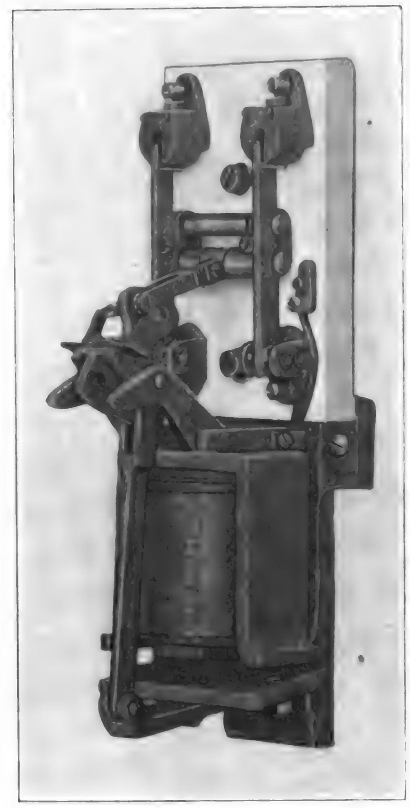

FIG. 4.—REMOTE-CONTROL SWITCH CLOSED.

the "disconnecting" position. Inasmuch as the magnet, *M*, is only subject to short

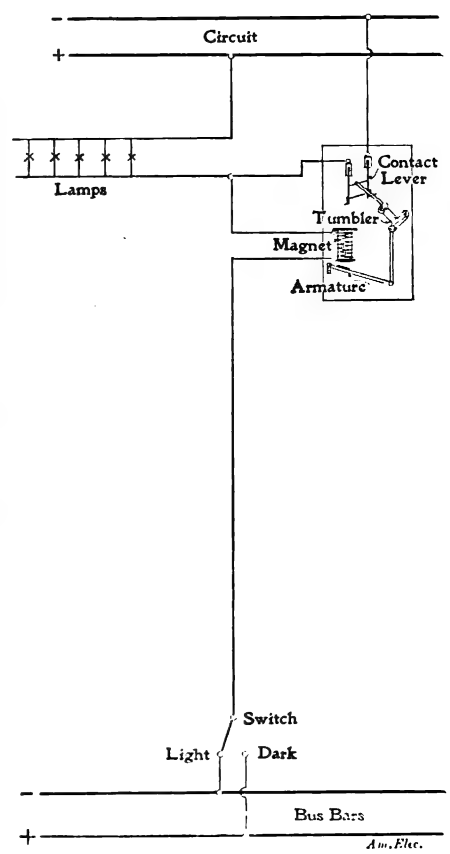

FIG. 5.—DIAGRAM OF CONNECTIONS.

current impulses the current consumption of the magnet is quite negligible.

The construction of the switch is clearly shown in the engravings which show the switch open and closed. The apparatus is

sufficient for a current intensity as high as 30 amperes, and is applicable to two and three-wire systems. The apparatus is enclosed in a cast-iron casing. When less

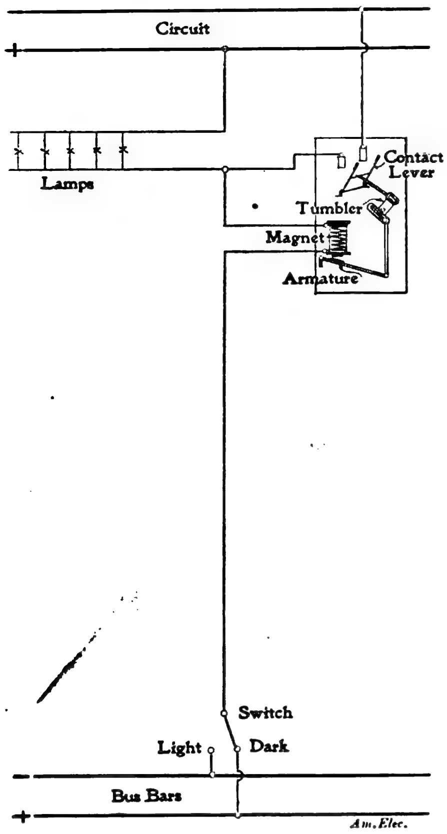

FIG. 6.—DIAGRAM OF CONNECTIONS WITH SWITCH OPEN.

than ten 16-c.p. lamps are in circuit, the reliability of the device is somewhat diminished by the lamp resistance being placed in the magnet coil, as the circuit is switched in. Ten instruments may readily be connected to a long distance wire having a cross-section of 5 sq. mm. and all operated from the one switch.

Electric Lighting of Passenger Trains by Storage Batteries.—The Pennsylvania Railroad is rapidly extending the use of electricity for lighting its passenger equipment by means of storage batteries, which are charged by the dynamos at the terminal stations. The system is proving very satisfactory. Some difficulties of a minor nature have been encountered and successfully overcome. The hard rubber battery cells, which were sometimes disturbed by the shocks to the cars in operation and temporarily disabled, are now placed in a lead-lined case. It shortly developed, however, that the lead lining was injured by electrolysis. It was found that at one of the charging stations there was a grounded wire which seemed to be responsible for the trouble; but there is liable to be more or less grounding at all the stations. In investigating the subject, the use of petrolite, a petroleum product, was suggested. The lead lining was dipped in this material, which formed a hard coating over the surface, and seems to have entirely obviated the difficulty.

Abstracts from Foreign Contemporaries

The Steam Turbine versus the Small High-Speed Engine.—The *Electrical Review*, of London, commenting editorially on the steam turbine and the small high-speed engine, says that "it is true that in the larger sizes of unit it (the turbine) has amply justified the claims of its supporters on the grounds of first cost, economy and simplicity, and this in spite of somewhat extravagant demands for additional power which has to be expended in the auxiliary plant. There seems, however, no immediate prospect of its being able to justify its supporters in the smaller sizes of unit, and it is this side of the question which deserves attention. * * * The general view held by those whose opinions deserve attention, fixes the limit at 500 kilowatts as the smallest size advisable—or permissible, so far as merits are concerned—for a turbine. * * * In the smaller sizes, turbine sets offer no inducement on the question of first cost, especially where allowance is made, as it should be, for the larger size of condenser required for giving the extra vacuum. On the question of simplicity and attendance in running, the performance of a good reciprocating engine of, say, 500 kilowatts, leaves little to be desired, and it is difficult to conceive of any other type of prime mover which will cost less, or be a source of less anxiety in the engine room. Finally, on the question of economy, the steam turbine has difficulty in approaching in these smaller sizes the economic results possible with the best forms of reciprocating engine, and this in spite of considerable additional power being expended in maintaining the most favorable conditions in the form of high vacua, conditions which are a charge of some weight on stations dealing with an average load factor, and which the reciprocating engine plant does not require. When this additional charge is taken into account, it leaves the small turbine sets considerably behind the reciprocating engine sets." Concerning the results of some steam consumption trials recently carried out by the Cork Electric Tramway Company on a 500-kw. vertical type turbine, the *Review* says: "It would, perhaps, scarcely be fair to compare the figures obtained in this isolated case with the numerous tests carried out on horizontal turbines, * * * * yet the figures are of interest in reminding us that the results obtainable with turbines of these smaller sizes are not what some would have us believe. At full load, with a steam pressure of approximately 150 lbs., with 100 degs. F. of superheat, and with a vacuum of 26.9 in., the steam consumption obtained at Cork was 20.6 lbs. per kw.-hour, and the best reliable results that have hitherto been obtained with horizontal turbines of the same size, and under somewhat similar conditions, can be put at about 19 lbs. of steam per kw-hour. * * * * Taking the results of some steam consumption tests obtained with reciprocating engines at Poplar for purposes of comparison with the results obtained at Cork—the output in both cases being similar—we find that the Willans engines at Poplar, with a somewhat higher steam pressure than prevailed at Cork (viz., 180 lbs. against 153 lbs.), but with a very much smaller degree of superheat (viz., 25 degs. F. against 104 degs. F. at Cork), and with a more usual vacuum (viz., 25 in. against 26.9 in. at Cork), gave a steam consumption of 18.64 and 19.52 lbs. of steam per kw.-hour—against 20.6 lbs. of steam per kw.-hour obtained at Cork. If the results usually promised for turbines in these smaller sizes were obtained with the same expenditure of power in condensing, one might be inclined to say there was little to choose between the two forms of prime mover, so far as economic performance was concerned. This, however, is not the case, and considerable additional power has to be expended to enable the turbines to give the results they do give. Hence it is that for sizes below 500 kilowatts, the advantage is in favor of the reciprocating engine, in spite of the greater cost of buildings, foundations etc., required for the latter. It would be unreasonable to argue—seeing what progress has been made in improving the steam turbine during recent years—that further improvements will not be brought about to justify the installaton of the smaller sizes, but, for the present, it is sufficient to say that the reciprocating engine, in the smaller sizes, still holds its ground."

Water-Cooled Rheostats.—A short time ago the *Engineer* contained a short description of a water-cooled iron wire rheostat used for dissipating electric energy during a dynamo test. It consisted of six lengths of iron wire, each .128 in. in diameter and 65 yards long, wound into coils and placed side by side in a wooden box with terminals at the ends of the coils connected up in parallel. This arrangement dealt with a current of 1660 amperes at 500 volts. About 27 gallons of cold water per minute were passed through the box. The test lasted five hours, and the wires showed no sign of deterioration. Each coil carried 276.17 amperes. The current density was 25,300 amperes per square inch. The theoretical drop in each coil was only about 247 volts, or, say, 50 per cent. of the actual drop. Admiring the compactness and cleanliness of the arrangement, but doubting the recorded drop, a correspondent of *The Electrical Times*, of London, had a small coil fitted into a box about 30 ins. long. The wire was of steel .0085 in. in diameter and 25 ft. long, wound into a coil 3/8 in. in diameter and 1-10 in. pitch. It was connected to the 220-volt service, and theoretically should have passed 10 amperes, but only 5 amperes would pass, and about half the length of wire had to be removed before 10 amperes would flow. The current density was 176,000 amperes per square inch, but the wire

carried it well. Clean tap water was used in the box to keep the wire cool. As the water does not act as a conductor no acid or salt is necessary. Subsequently two coils of this kind were used in parallel for testing a 75-kw. plant at 220 volts. The wire was of iron .0625 in. diameter. The box was 7 ft. long and 12 in. by 6 in. inside. There were four coils in the box, intended for testing two 75-kw. sets in parallel, but only one set was then tested, and only two coils were used. A small stream of tap water was passed through the box, but its volume was not measured. The temperature of the water rose only a very few degrees. The apparatus answered perfectly. The current density was 56,000 amperes per square inch. A very convenient arrangement is to put four coils in a box side by side with the terminals at one end provided with holes through which a horizontal copper bar can be passed and clamped. When the bar connects all four terminals in parallel the coils carry full load. When withdrawn from one terminal, three coils carry three-quarter load, two coils carry half load, and one coil carries quarter load. If switches be added, the load can be varied very quickly. A final adjustment of load within small limits can be made by varying the quantity of water passing through the box, for the resistance of the wire rises and falls as the temperature rises and falls, and the temperature depends upon the quantity of water passing through. The chief value of the device is in testing generating plants after they have been erected. Compared with a set of tubs, containing lead plates and salt water, replenished when the tubs boil over, by a jet of water from a hose pipe, directed by a man standing on an insulated platform, the contrivance is elegance itself.

Dublin Street Lighting System.—The arc light system of the city of Dublin, Ireland, is described in a recent issue of *Engineering* of London. In proportion to its area and population, Dublin, with its ad-

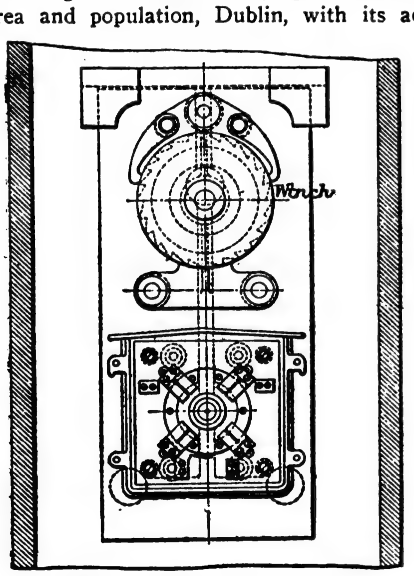

FIG. 1.—ARC LAMP WINCH.

joining townships, possesses a greater number of electric arc lamps than any other city in the United Kingdom. Electricity is generated in bulk at Pigeon House Fort, three miles from the city centre, and transmitted under a tension of 5000 volts, three-phase, to motor-generators in the city which convert it to 1100 volt, direct-cur-

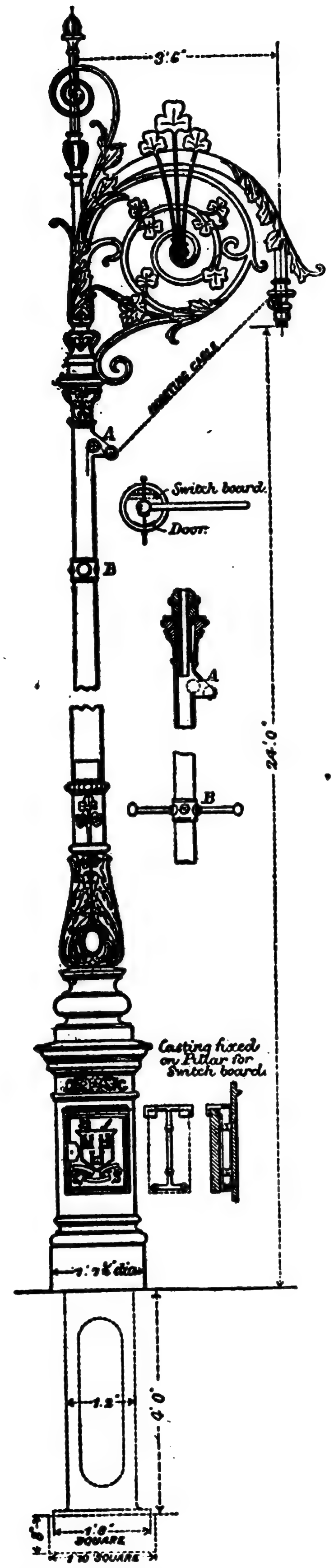

FIG. 2.—DETAILS OF DUBLIN ARC LAMP POST.

rent, for the arc circuits. From this station the arc light mains pass to five substations, where regulating resistances are provided. There are 23 circuits, having from 20 to 22 lamps per circuit, and it has been found necessary to adopt starting resistances upon the longer circuits in order to cut down the current at the moment of starting. Without the resistances, this current would be excessive, owing to the capacity of the cables. The posts (Fig. 2) have overhanging brackets, into which is worked the foliage of the shamrock. They weigh not less than 30 cwt. each, and the height to the arc is 20½ ft. The normal length below the surface is 4 ft. The base is bedded upon freshly-made concrete, and the hole is then filled and well rammed. The lamps are provided with lowering

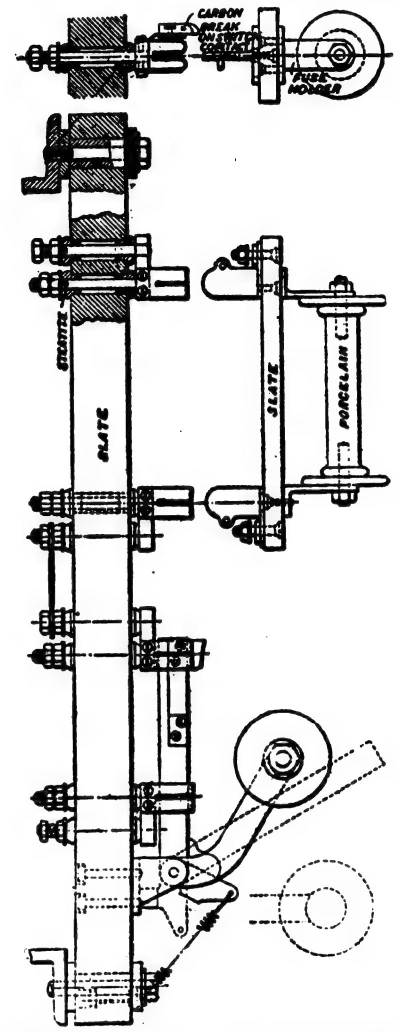

FIG. 3.—DETAILS OF SWITCH AND FUSE HOLDER.

gear, so that each lamp may be trimmed from the ground. The weight of the lamps is 65 lbs., and a flexible cable composed of six strands of ten wires each of 0.015 in. diameter is used for lowering and raising. This wire is built upon a hempen core well soaked in oil. The wire passes from the winch in the base of the pillar, up the stem and out at a point below the bracket between two 3-in. brass pulleys. These are so arranged that the inner pulley and the aperture through which the wire emerges are kept waterproof. The wire passes from this point across the under side of the bracket and enters the bracket tube over another pulley just above the nipple. The winches (Fig. 1) are provided with double pawls. When the point of one pawl is resting at the bottom of a tooth, the other is in the center of another tooth, and in this way

it is possible to use a fairly coarse pitch for the teeth while obtaining delicate adjustment. The handles are detachable, and are carried by the trimmers. When the spindle of the handle is thrust home, cams are opened, which raise the pawls; and similarly, when the handle is withdrawn, the pawls automatically bear upon the teeth of the winch. The possibility of the lamp's falling through carelessness is thus largely provided against. The rim of the wheel on the winch handle is of aluminum, and is

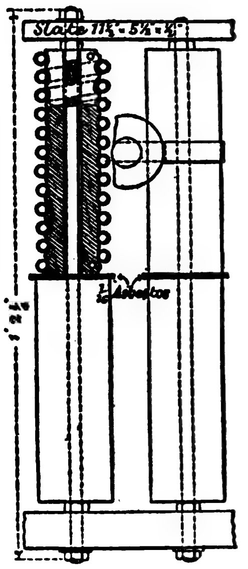

FIG. 4.—LINE RESISTANCE.

rounded and polished, being used by the trimmers as a hand-brake when lowering the lamps. In addition to the winch the base of the lamp contains an isolating switch (Fig. 3). This is mounted upon a china base, and has china contact carriers, the whole being contained in a weatherproof iron case. The switches are worked by steel keys encased in ebonite. The switch bridges over the lamp when it is desired for any reason to cut it out of circuit. No substitutional resistances are employed, and in practice it has been found that lamps burn equally well when two or even more lamps are cut out of a 20-lamp circuit. The line resistances for the lamps are shown in elevation by Fig. 4. The lamps themselves are of Verity's double-carbon type, constructed to burn 32 hours with 10 amperes. The cylinders are of corona and of copper, and the globes are opalescent, 20 ins. in diameter. Each circuit is fitted with double-pole fuses, with an automatic cut-out having carbon faces, as shown in Fig. 3. The specification regarding the burning of the lamps permits only a maximum potential difference of 3 per cent. across the terminals of any lamp. This means that each lamp on these long series must burn within 1½ volts up or down.

Counter-Current Jet Condenser.—In ordinary counter-current jet condensers of the vertical type the steam enters the condenser at the lower portion and rises upwards, whilst the condensing water enters the condenser at the top and falls downwards, thus insuring currents moving in opposite directions. It is, however, found to be inconvenient in some cases for the steam to enter the bottom of the condenser. The accompanying illustration, taken from the *Mechanical Engineer* of London, shows an arrangement by which the steam enters at the top or upper portion of the condenser and is then conveyed down a central tube of any convenient shape to the lower portion of the condenser, this tube being surrounded by trays for distributing the water which enters the upper portion of the condenser. By this arrangement, a counter-current effect is obtained in a jet condenser in which the steam and water both enter at the upper portion. The condenser is arranged in such a manner that the steam entering the upper portion of the condenser by the inner tube is partially condensed by admitting a spray of water at different points in the inner tube, whilst the remaining steam, after descending to near the bottom of the condenser, rises upwards in the condenser and outside the inner tube, and then meets the shower of condensing water falling from above. The condensation in the tube reduces the volume of steam passing through it and thus permits of a smaller tube than would be otherwise necessary. In the illustration *A* is the condenser casing, of cylindrical form. *E* is the inner tube, *C* the water inlet, *B* the outer and inner water distributing trays. The exhaust steam entering at the top of the inner tube *E* passes downwards and then rises around the outside of this tube; it

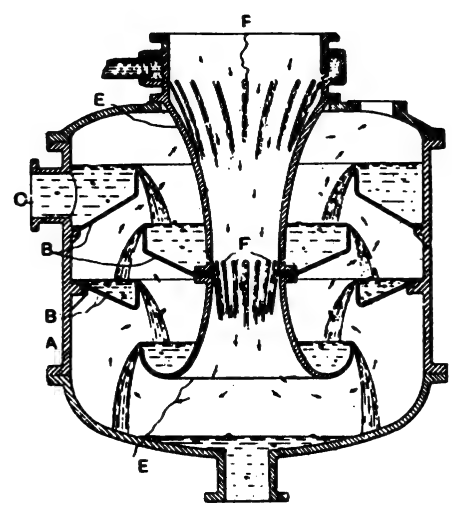

FIG. 5.—COUNTER-CURRENT JET CONDENSER.

then ascends through the condenser, coming into contact with several cascades or sheets of water; by this means the steam on emerging from the bottom of the inner tube flows in a complete counter-current direction to the condensing water, which entering the top tray overflows at the edge of this tray and then falls successively over the edges of the lower trays. The form and arrangement of these trays is such as will give a thorough mixing of the steam and water, and at the same time allow a free passage of air and vapor to the outlet to the dry air pump, which outlet is shown at the top of the condenser. The holes or slots, *F*, arranged in the inner tube allow a certain amount of condensing water to enter the tube and partially condense the steam during its passage through the tube.

Transformers in Series for High Tensions.—In a communication to the *Electritchestvo*, reprinted in the London *Electrical Engineer*, Mr. P. Kovalef makes a suggestion for obtaining high-tension current by a new method of employing several ordinary transformers. It is sometimes desirable to obtain a much higher voltage than that for which transformers at hand have been calculated. To that

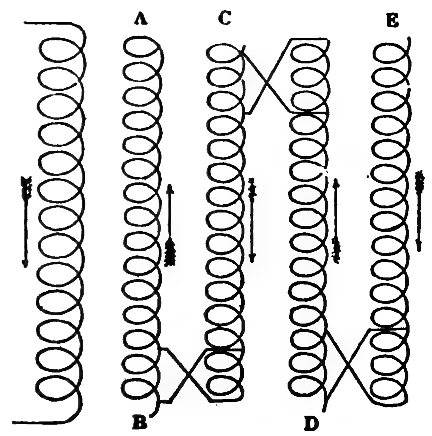

FIG. 6.—TRANSFORMERS IN SERIES.

end, Mr. Kovalef observes that the secondary wires of two or more transformers are generally connected in parallel with a source of low voltage, while the primary wires are connected in series. This manner of connecting, however, involves a high potential difference inside the separate transformers, between the high and low tension coils, and therefore it becomes a matter of risk to connect in series more than three transformers in order to obtain a voltage more than three times as high as the normal voltage of a transformer of a given type. The connection of transformers, illustrated in the accompanying diagram, gives a possibility of reaching much higher voltages. The low-tension winding of only one transformer is connected to the source of e.m.f., and the primary windings of the remaining transformers are left free, connections being established among the high-tension windings. Shunts are taken from these windings at equal distances from the end of each winding, say at one-sixth the total length. The manner of making these connections is shown in the illustration. The second transformer is fed by the first, the third by the second, and so on. It will be seen that, notwithstanding the number of transformers connected in circuit, the inside tension in each of them will not exceed the tension between the extreme points of the winding, while the total tension of the whole circuit will be equal to the geometrical sum of voltage of all the transformers, considering, of course, the tension between the points *B* and *C*, *C* and *D*, *D* and *E*, etc. The above method may also be modified by using the secondary wires of the transformer. Mr. Kovalef acknowledges, however, that the question of voltage obtainable often becomes more complicated owing to the self-induction of the transformers, and the total sum of voltages differs greatly from their algebraic sum.

"Bifluid" Tachometer. A simple and effective speed indicator called the "Bifluid" tachometer is described in the London *Mechanical Engineer.* One type of indicator is shown in the accompanying illustration. There are other instruments which can be mounted direct on any revolving part. The principle is easily explained. A revolving body which consists of a reservoir and an inner and outer tube contains two fluids of widely different specific gravity. The centrifugal force acts on the heavier fluid, pressing it outward and causing the light fluid to rise in the inner tube. Scales are fitted round the outer tube, which may be graduated to read revolutions per minute, miles per hour, feet per second, or knots per hour. The light fluid is red, and the scales are white, so that a very clear and distinct reading is possible. Up to four scales for different speed ranges can be fitted to one instrument, which allows of slight and rapid speed changes to be easily checked, and a large range of speed is thus provided for. An accuracy of ½ per cent is guaranteed by the makers. The instruments are suitable for fast or slow running machinery, and the scales can be graduated for speed ranges from 15 to 10,000 r.p.m. They are, according to the makers, absolutely reliable, the fluid rising and falling instantaneously at all speed changes with great precision.

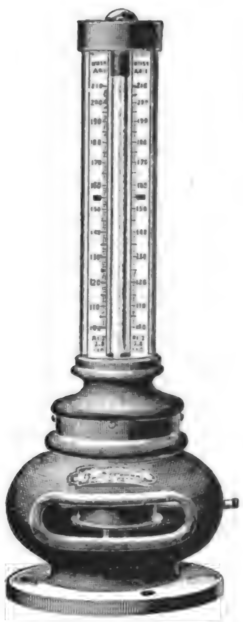

FIG. 7.—BIFLUID TACHOMETER.

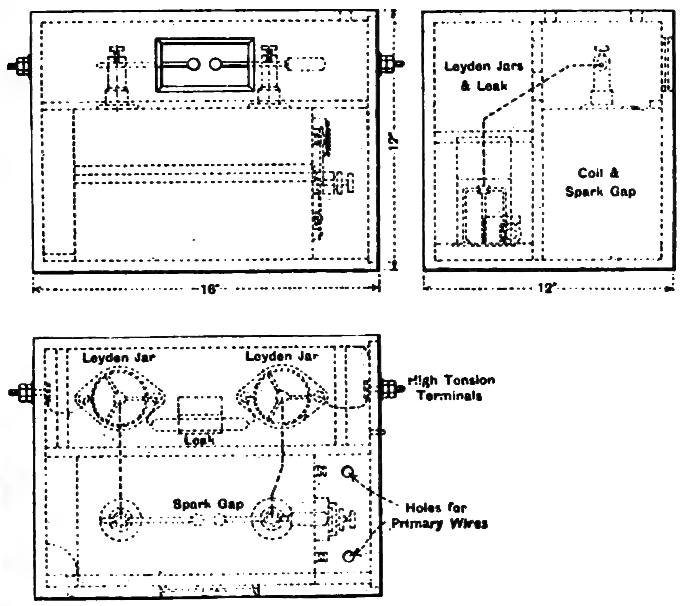

FIG. 8.—LODGE ELECTRIC IGNITER.

Lodge Electric Igniter for Gas Engines.—The London *Electrician* gives particulars of the Lodge igniter for gas engines, the chief claim for which is that the firing of the explosive charge is rendered quite positive and independent of leaks due to moisture or soot at the sparking plug. Fig. 8 shows the general arrangement of the apparatus, whose constituent parts are an induction coil, two Leyden jars, a leak and a spark-gap. The primary of the induction coil is fed from an 8-volt secondary battery, the current being given a pulsating character by a trembler or any other suitable device. It will be seen from the drawing that the secondary of the high-tension induction coil is connected up to the outer coatings of two Leyden jars, the inners of which are connected to the adjustable spark-gap. This spark-gap is an auxiliary device for producing well-defined disruptions, and must not be confused with the working spark-gap within the engine cylinder. The last-named spark-gap is connected directly to the two high-tension terminals of the induction coil, one of the connections being usually formed by the bed-plate of the engine. In order that the Leyden jars may be charged it is necessary to have some form of leak between the outside coatings of the jars. This leak must be of sufficient value to allow the jars to charge rapidly, and yet not diminish the volume of the spark in the cylinder by allowing the discharge current to pass through it. In the case of the gas-engine igniter a special form of liquid resistance is used, which offers a fairly good path to the charging current, but offers a large resistance to the oscillating discharge. The jars have a capacity of the order of 0.0001 microfarad.

Apparatus for Condensing Steam.—The London *Mechanical Engineer* describes some improvements in condensers for steam engines especially applicable to the type of condenser known as the "counter-current" and also applicable where separate pumps are used for taking the water and air from the condenser. The arrangement is illustrated herewith. The condenser, 1, is connected by a pipe, 2, to some known form of separator, 3, in which is placed a float, 4, so arranged as to open an air-valve, 5, thus admitting air into the pipe, 6, which leads to the air pump, 7. The operation takes place when a heavy flow of water comes over from the condenser, and by opening the valve, 5, the vacuum in the pipe, 6, is reduced for the time being, and the injection water resumes its normal intended direction of flow. The separator is provided with a pipe, 8, to take the separated water or fluid back into the condenser or into the pipe, 9, which leads to the water pump, 10. The flow of water into the condenser through the water supply pipe, 11, is controlled and adjusted in accordance with the level of the water in the condenser by the float, 12, acting on the auxiliary injection valve, 13, through the connecting rod and crank, 14, so as to open or close the latter as required, the level of the water being controlled by the water pump, 10. The float is also connected by the connecting rod and crank, 16, to the throttle valve, 15, or speed-varying mechanism for controlling the pump, and in its lower position or positions operates the valve, 15, for reducing the speed of the pump or pumps. The float is also connected by the rod and crank, 18, to an air valve, 17, leading into the pipe, 6, and when the float approaches its top position the valve is opened, thereby admitting air into the pipe for reducing or destroying the vacuum in the condenser, thereby checking the tendency of the water to rise and flow into the steam inlet pipe 19, which might occur if the water pump worked inefficiently, broke down, or from too large an injection of water.

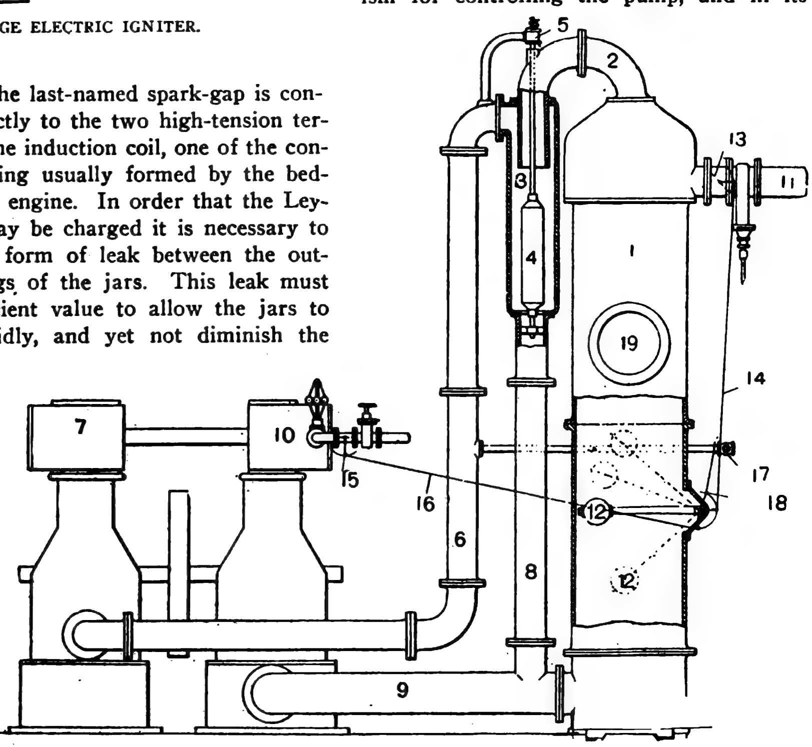

FIG. 9.—APPARATUS FOR CONDENSING STEAM.

Some Recent Electrical Patents

Dynamo Brush-Holder.—The acme of manufacturing simplicity, so far as brush-holders are concerned, appears to have been reached in the form patented by Mr. Fredrick M. Conlee, of Madison, Wis., and illus-

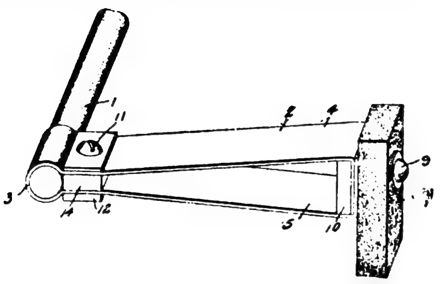

FIG. 1.—DYNAMO BRUSH HOLDER.

trated by Figs. 1 and 2 herewith. The brush-holder consists merely of a strap of spring metal, such as phosphor-bronze or spring brass, bent into the form shown by Fig. 2, together with small blocks, 10, 12 and 14, the functions of which are obvious. The loop, 3, is made to fit the brush-holder stud, as shown in Fig. 1, and is clamped to it by means of the screw, 11. The free ends of the strap lap each other, so that the holes, 6 and 7, match, and the screw, 9, which secures the carbon brush to the holder, passes through these two holes and is threaded into the block, 10, Fig. 1. The resiliency of the strap is relied upon to press the brush against the commutator and to allow it to yield to irregularities in the commutator surface. Patent 779,265.

Alternating-Current Railway System.—Fig. 3 illustrates diagrammatically the latest development in the alternating-current railway field, and is taken from a patent issued to Mr. J. H. Hallberg, of New York. The general scheme of the system comprises single-phase, alternating-current supply converted by means of a motor-generator into low-voltage polyphase alternating currents, which may also be of a lower frequency than the supply current, the polyphase currents being used to drive induction motors on the cars. The system is adapted to combined interurban and urban service, the cars for such combination service carrying a motor-generator set with its exciter. Cars for purely urban service, would require, of course, no motor-generator to operate on the system. Referring to the diagram, 5 is a single-phase alternator delivering current to a feeder, 6, to one side of which the rural trolley line, 8, is connected, and to the other side, the track, 10, of this part of the system. The high-potential, single-phase main, 6, is also available for the supply of lights and other single-phase apparatus. The city circuit is supplied from sub-stations, one of which is indicated diagrammatically at *X*. This station contains a motor-generator consisting of a single-phase synchronous motor, 22, and a polyphase generator, 26, belted to which is the direct-current exciter, *G*. For convenience in drawing, the members of the motor-generator set are shown with revolving-field magnets. The usual resistances are provided for regulating the field strengths of all three machines, and a storage battery, *H*, is provided for exciting the machines in case of an accident to the exciter, *G*. The polyphase generator of the motor-generator set delivers current through the mains, 12, to the three-phase conduit conductors of the city line, as shown at *B*. Each car intended to operate jointly on the city and country sections is provided with exactly the same equipment as the sub-station, except, of course, as to the size of the apparatus. In the drawing, *C* represents the synchronous motor of the motor-generator set, and *D*, the three-phase generator of that set. The car is provided with a double-throw switch, 57, which connects the three-phase motors, *F*, with either the polyphase generators, *D*, or the contact shoes, 17, 18 and 19, according to the section of road on which the car is operating. Obviously, it makes no difference so far as the railway is concerned what the frequency of the generator, 5, may be since the motor-generators, 22, 26, or *C*, *D*, can be wound to change the frequency to suit the railway requirements. The first claim of the patent is astonishingly broad in view of the state of the art; it covers a system of electrical distribution for railways comprising a source of single-phase current, means for converting it into polyphase currents, and polyphase motors on motor vehicles actuated by the polyphase currents. Patent 779,475.

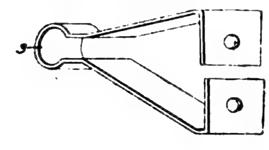

FIG. 2.

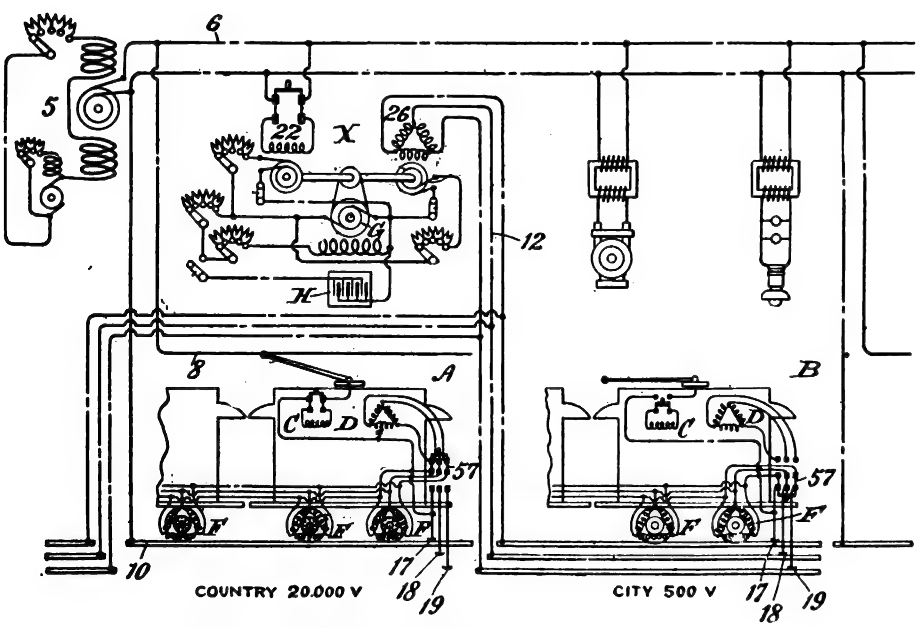

FIG. 3.—ALTERNATING-CURRENT RAILWAY SYSTEM.

NORTHWESTERN ELECTRICAL CONVENTION.

The Northwestern Electrical Association held its thirteenth annual convention at Milwaukee, January 18 and 19. An interesting paper on "The Successful Joint Utilization of Small Water Powers," was read by Mr. W. G. Jackson, of Madison, Wis., in which the author described how the Janesville Electric Company had gradually developed a system whereby all the power for supplying its entire service may be drawn from any one of three plants, and two of the plants are arranged so that the generators may be driven by either water or steam. Mr. O. M. Rau read a short paper on "Direct vs. Alternating-Current Distribution," in which he went over some familiar ground and also brought out the point that the use of turbine-driven alternators makes a 60-cycle rotary converter as stable as one of lower frequency and thereby removes the objection to the use of 60 cycles in a generating plant involving the application of rotary converters. He drew a comparison between direct-current distribution from rotary converter sub-stations and alternating-current distribution from transformer sub-stations, the generating plant being the same in both cases and the transformers being cut in and out of circuit according to load requirements just as the rotary converters would be. The figures deduced showed full-load losses of 21.4 per cent for the complete alternating-current system against 27.6 per cent for the mixed system; 17.2 per cent for the full alternating-current system at ¾ load against 23.4 per cent for the other; 13 per cent at half load for the

C. H. WILLIAMS,
President Northwestern Electrical Association.

full alternating-current system against 19.7 per cent for the mixed, and 8 per cent for the full-alternating-current system at ¼ load against 17.1 per cent for the mixed system. His comparison of the first cost of plants of the types described, based on a station having 15,000 kilowatts full-load output capacity, showed a saving on the first cost of apparatus and buildings for sub-stations alone of $130,000. It was not stated what percentage of the total cost this is. The paper was based on an investigation of the conditions in the city of Racine, and as a result of the investigation the lighting distribution system there was changed from direct-current three wire to single-phase alternating-curent at 60 cycles.

In a paper on "The Rating of Street Lights," Prof. George D. Shepardson urged the making of contracts with municipalities in such manner that both parties to the contract will know exactly what is required and either party can determine accurately whether or not the contract is being carried out. He advocated lighting contracts based on the kilowatts supplied. Mr. C. H. Williams read a paper on "Distribution and Dollars," in which he analyzed the question of the most profitable incandescent lamp efficiency, the cost of lamp renewals, losses in transformers, and other factors affecting the cost of distribution. In a paper on "Series Alternating Arc Lighting," Mr. E. P. Warner appeared as a staunch advocate of this class of service and eulogized almost everything involved in a system of this sort. He brought out the important fact that as a rule arc lamps are not sufficiently insulated from their supports and that a lamp should be treated as though all of its exposed parts were alive. "The Single-Phase Railway and its Possibilities," was the title of a paper by Mr. Clarence Renshaw, of Pittsburg, who held up to view all of the well-known limitations of the present direct-current railway system and to describe at length the Lamme single-phase series railway motor, which was apparently considered a panacea for all the ills of railway car equipment. Mr. J. W. Shuster, of the University of Wisconsin, read a paper in which he emphasized the well-known desirability of working up a day motor load in central stations.

At the election of officers for the ensuing year, Mr. C. H. Wiliams, of Madison, Wis., was elected president; Mr. Roger N. Kimball, of Kenosha, Wis., first vice-president; Mr. Harold Almert, of Oak Park, Ill., second vice-president, and Mr. William R. Mercein, of Milwaukee, secretary and treasurer. The board of directors consists of Messrs. P. H. Korst, of Janesville, Wis.; Ernest Gonzenbach, of Sheboygan, Wis., and H. J. Gille, of St. Paul, Minn.

CENTRAL STATION ENGINEERS.

IV.

Ernest H. Davis.

Ernest H. Davis was born in Philadelphia, Pa., on November 13, 1859. He was educated in the public schools of his native city and afterwards took up the study of law, being admitted to practice at the bar in 1882. He followed his profession for a while; but having inclinations for industrial and transportation enterprises, he gave up his practice to enter the steam railroad field, eventually becoming president of the Brooklyn, Bath and Went End Railroad Company, of Brooklyn, N. Y., which company

ERNEST H. DAVIS.

is now a part of the Brooklyn Rapid Transit. About the year 1894 he became interested in the Lycoming Electric Company, the Williamsport Passenger Railroad Company and other street railway companies of Williamsport, Pa. He also became associated with the Edison Electric Illuminating Company later, and is still connected with the active management of these various enterprises. In 1903, Mr. Davis was elected president of the Pennsylvania Street Railway Association. For the past few years Mr. Davis filled with remarkable success and efficiency the office of secretary of the National Electric Light Association, and at the convention of the association held in Boston last May, Mr. Davis was elected president of that organization.

An Uninterrupted Run of a year's duration is credited to a Parsons steam turbine built by the Swiss firm of Brown, Boveri & Co.

AN INDEPENDENT TELEPHONE ASSOCIATION FOR TEXAS.

At a meeting of owners of independent telephone exchanges, held in Dallas, Tex., recently, there was inaugurated a state association of independent telephone companies. At this meeting, which was the outcome of some able missionary work by Mr. A. A. Miller, manager of the North Electric Company's Dallas office, Mr. E. W. Dunaway, general manager of the Paris telephone exchange, was elected temporary chairman, and Mr. J. B. Earle, secretary of the Texas Telephone Company and general manager of the Brazos Valley Telephone Company, of Waco, was elected temporary secretary. The organization of the new association was perfected with an absence of friction and unanimity of sentiment which augurs well for the future of the body.

NOTES.

The United Engineering Building.—The consulting engineers for the construction of the United Engineering Building to be erected under the Carnegie gift were appointed at a recent meeting of the Conference Committee. Mr. C. O. Mailloux was selected for the consulting electrical engineer, and Mr. Alfred R. Wolff as consulting engineer for heating and ventilation on behalf of both the United Engineering Building and the Engineers' Club. The firm of Bates & Neilson were selected as consulting engineers to look after the interests of the Engineers' Club.

A Point for Wireless Telegraphy.—The peculiar value of wireless telegraphy in marine work was demonstrated on January 3, when the steamer "Pilgrim," of the Fall River Line, collided with a schooner between Newport and Fall River. A thick fog was prevailing at the time, and the steamer struck the sailing vessel a glancing blow on one side. Fortunately no damage was done to the schooner below the water line, but this was not known at the moment, and the "Pilgrim" immediately summoned help by a wireless telegram to the torpedo station at Newport and stood by until the tug sent out from the station arrived.

Industrial Opportunities in Italy.—In a recent United States Consular Report reference is made to the improvement of water powers in Italy by means of which there will be available in the city of Venice about 10,000 electrical horse-power. This, it is stated, will open a good market for electri-

cal machinery, fixtures and supplies, but the Consul expresses the opinion that catalogues are of no service in making sales; this can only be done by a salesman canvassing the district. It is stated that the electrical apparatus and supplies manufactured in the United States could easily predominate in the Italian market if the opportunity were promptly embraced by American manufacturers.

Boston's Evening Polytechnic School.—The Young Men's Christian Association, of Boston, Mass., in its Department of Applied Electricity, has inaugurated an evening polytechnic school of unusual merit. The Department of Applied Electricity is in charge of Prof. William L. Puffer, of the Massachusetts Institute of Technology, and the Advisory Board includes members of the staffs of the Edison Electric Illuminating Company and the Boston Elevated Railway Company. The first term of this school opened January 10. The work of the present year will consist of a lecture course of eight weeks, the lectures being delivered on Tuesday and Thursday evenings, a recitation on each Friday evening, and a laboratory course which will open at the conclusion of the lecture course.

National Electric Light Association.—Mr. Henry L. Doherty, chairman of the Committee on Membership of the National Electric Light Association, is doing some vigorous work in the direction of increasing the membership. Small pamphlets have been prepared, containing extracts from the constitution relating to membership and a blank to be signed by an applicant for membership. These have been sent judiciously to companies and persons eligible for membership under the different classes, together with circular letters calling attention to the booklet and to the advantages of membership. The booklet is attractively prepared and the arguments are convincing. Mr. Doherty's campaign bids fair to produce an enormous increase in the class of individual membership and should also augment the company membership very considerably.

Increasing Furnace Efficiency.—According to the claims made by Cyrus Prosch, of Coatesville, N. J., he has devised a method of greatly increasing the efficiency of the ordinary boiler furnace without a proportionate increase in operating expense. Broadly stated, his method consists of delivering into the furnace, above the fire, intermittent jets or streams of air in addition to that taken into the furnace from below, by draft, in the usual way. The idea of introducing air above the fire is not new, but Mr. Prosch's method of admitting the supplementary air intermittently is claimed to give results far and away superior to those obtained by continuous admission. The improvement obtained, he states, depends not only on the quantity of air admitted, but on the frequency of the admissions and their duration. We do not vouch for the soundness of Mr. Prosch's claims, but he himself is undoubtedly convinced of the efficacy of his method and makes the claims in all sincerity.

Institute Annual Dinner.—The annual dinner of the American Institute of Electrical Engineers will be given in the ballroom of the Waldorf-Astoria, New York City, on February 8, and promises to be a most interesting occasion. In view of the recent opening of the Subway, thus adding underground traction to the domain of electricity in America, the adoption of electric locomotives by the New York Central and Pennsylvania Railroads for their great Manhattan terminal divisions, the equipment of the Long Island Railroad with electricity, and other signal events, the Institute has decided to devote this dinner to emphasizing the triumph of electric traction. A number of men prominent in this field will be present, and some novel features will be introduced. As is usual on these occasions, ladies will be present. The participation of the ladies was a feature that elicited Mr. Carnegie's enthusiastic commendation at the famous Institute Library dinner, at which he made his gift of $1,000,000 for the United Engineering Building. Over 400 were seated at the Edison dinner last year, and the attendance in February promises to be equally large.

Proposed Investigation of New York's Lighting and Railway Service.—The Committee on Gas and Electricity, of the Merchants' Association of New York, has presented to the Legislature a memorial asking the passage of a resolution authorizing the appointment of a legislative committee empowered to examine into, report upon and make recommendations concerning the conditions surrounding the production, distribution and cost of gas and electric light in the city of New York and of the operation and control of electrical subways in this city. The object of the resolution is to determine the reasonableness of the charges for gas and electric light service and to investigate the city's equity in the accounts and earnings of the subways. The memorial appears to be chiefly an agitation of the question of municipal ownership. It contains the statement that while Manhattan Borough pays $146 per annum for each arc lamp of 2000 nominal candle-power, the prices charged by various electric light companies in "sixty-eight other cities where conditions similar to those in New York exist" average $88.60, for the same size of arc. Irrespective of the merits of the gas and electric light companies' side of the question, the argument presented in the memorial is conspicuously unsound for the reason that there are not sixty-eight other cities in the entire world where conditions similar to those in New York exist.

The Coming Electric Light Convention.—Nothing is being left undone in planning for the convention of the National Electric Light Association to be held in Denver and Colorado Springs the week of June 6, and the committees in charge of the preparatory work will continue their labors vigorously from now until the time of the meeting. A great many members have written to the secretary and members of the committees, assuring their attendance and the attendance of many others. This has encouraged those engaged in making preparations, and they are now planning for the entertainment of several thousand visitors. The committee on advertising has reversed the usual conditions. Instead of depending upon the railroads for all of the advertising, this committee is putting out its own matter, and in such a way that the publicity will be of the highest class possible under the circumstances. A considerable quantity of the matter that is going out, however, is being supplied by the railroads, but it is much more expensive than usual. As an illustration of this is cited the sending out of the souvenir cards regularly sold by stationers and others. These go to all parts of the country and show scenic points that will be shown to the visitors. Booklets are being sent to members and others containing detailed information regarding the hotels of almost the entire state, from which the recipient can determine the exact cost of his stay in the several points he may visit; the information is all official, from the hotel men themselves. Another booklet contains detailed information regarding side trips and scenic points.

Operating Cost of Electric Elevators.—We reprint the following data upon the cost of operating electric elevators appearing in a recent circular of the Cincinnati Gas and Electric Company. While the cost varies greatly with the type, and the extent to which the elevator is used, the following figures, we think, give a fair average for the guidance of prospective users of electric elevators:

SIX MONTHS' AVERAGE.

No.	H.P.	*Freight Elevators* Average Monthly Cost.	No.	H.P.	*Passenger Elevators* Average Monthly Cost.
1	10	$11.92	1	15	$39.54
1	10	10.00	2	20½	19.05
5	20	33.01	1	18	65.83
1	5	5.00	2	17½	17.30
1	5	4,00	2	22½	23.57
1	5	5.00	1	15	14.22
1	5	4.00	5	73	59.40
1	5	7.37	2	32	38.16
1	5	4.00	3	38½	34.55
1	5	11.86	2	10½	19.80
1	10	9.50	1	8	9.73
1	10	9.50	1	8	14.87
1	8½	9.49	1	11	18.42
2	25	23.75	1	15	9.15
1	5	3.50	1	15	22.01
1	10	9.50	1	15	4.75
1	5	4.75	2	16½	17.62
1	10	11.30	1	12½	14.66
1	8	7.60	2	12½	12.33
1	20	28.06	2	11	17.74
1	7½	7.12	3	41	37.95
1	5	4.75	1	10	23.49
1	5	4.60	1	16	18.24
1	5	5.25	1	10	19.05
1	7½	7.12	1	10	19.50
			1	13	13.30
30	221½	$241.95	1	10	18.98
			1	26	35.31
			45	523	$658.58

Average cost per elevator per month, $8.
Average cost per month per horse-power, $1.09.

Average cost per elevator per month, $14.64.
Average cost per month per horse-power, $1.26.

The average monthly cost for a freight elevator is $8.00 and for passenger elevators $14.64. It will be evident that these figures cannot be duplicated in a steam or hydraulic equipment.—N. Y. Edison *Bulletin*.

ESTABLISHED 1889.

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CECIL P. POOLE, Editor.

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CONTENTS.

Electric Hoists in Building Construction.

It seems odd, in view of the "state of the art" of electrical engineering, that the out-of-date donkey-engine hoist should still be used in any city of respectable size for handling material in the erection of buildings. Electrically-driven hoists have long been available; they require no licensed engineer, are more easily portable, more economical in operation, more flexible in control, and entail an immensely lower fire risk than the steam hoisting engine, not to mention the absence of fuel supply, noise, smoke and ashes. Fuel economy does not affect the problem greatly, since the cost of the fuel used by the most wasteful hoisting engine is a bagatelle in the total cost of the building. But the vastly greater convenience of application, reduced fire risk and lack of necessity for a skilled attendant are of ample importance to justify the use of motor-driven hoists to the extinction of the antiquated mechanism so generally used now.

Motor-Driven Machine Tools.

That the driving of machine tools by electric motors is no fad but a permanent development will not be questioned by any thinking engineer. The many advantages of electric drive are now obvious; leaving aside all others, the better arrangement of the tools, the facility of control and the capacity for momentary overloads have established motor drive securely. Having reached this stage of development, it behooves all machine tool builders to face squarely the fact that the best results from a motor-driven tool can be obtained only when the tool has been designed from the start with a view to motor drive. It is entirely practicable to "hitch up" a motor to an existing machine tool or other piece of similar machinery, and the article by Mr. Hanchett, which we print elsewhere in this issue, indicates methods of doing this which will be found most useful to all who are confronted with the problem. It is undeniably true, however, that this procedure is a makeshift and therefore cannot endure; the proper method is to build the machine specifically for motor drive, with proper accommodation for the motor and appropriate means of power transmission from the motor shaft to the main shaft of the driven machine.

The foregoing refers, of course, only to individually-driven machines, but, although individual drive appears to be extravagant in the case of tools requiring less than two or three horse-power, the tendency is strongly toward equipping every machine with its own motor, down to the smallest commercial size of motor. If tools are designed especially for individual motor drive, the discrepancy between the costs of singly-driven and group-driven machines will be much less than it is now. There seems to be a magnificent opportunity just here for tool builders and motor builders to "get together" and perfect a joint policy that will enable them to produce a combined tool and motor which will not be prohibitively expensive in comparison with the same tool belt-driven in a group by part of the power from a larger motor. With the number of variable-speed motors on the market, there should be no difficulty in carrying out such a policy without involving unpleasant commercial tangles or restrictions.

Fire Risks in Isolated Plants.

The correct design of a modern isolated plant involves the solution of so many problems and the consideration of so many diverse questions that the matter of fire risk in the plant equipment often receives little if any attention beyond that given to the building or establishment as a whole. Then again, it is frequently the case that by the time the necessary and "extra" expenditures for the plant have been met or provided for, no money is available for the installation of automatic alarms, sprinkler systems, etc. Fortunately, the majority of isolated plants do not in themselves constitute serious fire hazards. If designed properly and installed according to the design, the danger of overheating neighboring inflammables from smoke flues, chimneys, ash piles, etc., is very small. The fire risk from electric wiring and switches is practically *nil* where vigilant insurance inspectors are detailed.

Even in the best-designed isolated plants, however, there is always *some* fire risk, and this can be reduced to a negligible quantity by inexpensive precautions and prudent operation. Thermostat alarms should be installed at all points near sources of possible conflagration and also at different points, symmetrically located, throughout the establishment. In the way of simple but practical means for fighting fires in their incipiency, several pails of sand, with small scoops for proper distribution, two or three asbestos blankets three or four feet square, and a moderate number

of approved fire extinguishers will go far toward minimizing the risk from fires after they start. In the way of guarding against the starting of fires, the disposal of greasy waste in a metal receptacle having a self-closing cover, the daily cleaning of floors and closets, the keeping away from incandescent lamps or other heat sources of inflammable substances such as paper, cloth, excelsior, etc., the intelligent use of lamp cord in the vicinity of pipes and other metal structures, the storage of gasoline out of doors and the abolition of matches are all such simple and obvious precautions that one would think it unnecessary even to suggest them; nevertheless, there are hundreds of plants in which most if not all of these are either indifferently observed or neglected entirely.

An excellent plan for insuring attention to precautionary measures of the character just indicated is to work out a system of report blanks which will show the condition of the plant with respect to fire hazard, and have these blanks filled out by the chief engineer at stated intervals—say weekly. One blank should show the quantity of water in the storage tank, and the actual condition, in detail, of the fire pumps; the number of fire extinguishers, the number and condition of thermostats or other alarm apparatus, the condition of valves affecting the fighting of fire, the accumulation of inflammable or heat-producing débris and other information affecting the fire risk, in the fullest detail. Such a blank can easily be worked out to fit any plant, from the smallest to the largest, and it should be filled out with the greatest care, accuracy and regularity.

A Farcical Investigation.

The Comptroller of the City of New York is prosecuting an alleged investigation of the cost of street lighting by municipal plants, the ostensible object of the "investigation" being to determine whether or not New York could probably operate its own plant more economically than it can buy service from the local companies. From the character of the information disclosed, the bullying attitude of the "investigators" toward citizens who attempt to find out what it all means, and the evident determination to rush into municipal ownership whether or no, it would seem that peanut politics has much more to do with the Comptroller's feverish antics than virtuous solicitude for the proper disbursement of the taxpayers' money. Thus far not a single completely accurate statement concerning the cost of municipal lighting in cities afflicted with such plants has been brought out, so far as the published accounts of the "investigation" go.

Time-Saving Tables.

Any means of reducing the time required in making even the simplest computations, as well as saving one's mental wear and tear, is usually met with a warm welcome, and we trust that the set of scales and the table printed on pages 93 and 94 will be found of sufficient merit to be classed as "means" of the kind mentioned. The results obtainable with the scales, while seldom absolutely accurate, will in almost every case be found as nearly accurate as it is possible to obtain without radically altering the depth of the magnet winding and going through the elaborate work of redesigning the winding throughout. The table of mean lengths per turn of wire should be of general value, since it is based on a clearance between the magnet core and the bore of the coil which, without being excessive, is ample for any ordinary bobbin material or insulation. As stated in the explanatory text accompanying the table, the mean length per turn of wire in a magnet coil is a determining factor in the lay-out of a winding for a stated potential at its terminals; it is also important in dealing with coils built for stated currents, since the resistance of the coil must be ascertained in order to know what voltage will be required and what the loss in watts will be. The relation of watts to coil surface is another important factor in magnet windings. It is expected that a table of coil circumferences, on a plan similar to that of the table of mean lengths, will be ready in time for publication next month. This will be of service, of course, in readily ascertaining the coil surface per unit of length parallel to the core.

The Telephone in Isolated Plants.

The use of the telephone in the engineer's department of an isolated plant, though not a matter of vital importance in many cases, is well worth consideration by owners of such plants. Most establishments operating their own lighting and power plants are equipped with a local system of communication between different departments—usually an interior telephone system—but this is of no service for communication with the outside world by the chief engineer of the plant. Whenever it becomes necessary for him to employ the city exchange service, he usually has to leave his department and use a general telephone instrument, which may be in such demand as to cause appreciable loss of time and money by delay. Upon investigation, it will usually be found that the chief engineer of an isolated plant has many occasions per week to use city exchange service, and in almost every case his telephonic conversation has reference to matters of record in his department, which record could not be consulted while using a remote telephone instrument. Again, in case of an accident causing personal injuries, the availability of a telephone right in the engineer's quarters might easily be worth many times the annual cost of the service. In establishments having branch exchanges connected with the city exchange, failure to put an extension instrument in the chief engineer's department is short-sighted to the last degree.

Communications for Publication.

Readers interested in our department of Letters on Practical Subjects—and we cannot imagine any who are not so interested—will find at the head of that department a notice to the effect that letters for publication in a given issue of the paper must be in this office not later than the 15th day of the month preceding that issue. This rule has not been adopted from mere arbitrariness; it is strictly necessary in order that the printing of the large number of copies issued each month may be finished in time to mail the copies on the last day of the month. The paper cannot be printed all at once; it has to go to press in sections and the section containing the letters department is necessarily closed early in the month—hence the rule to which we are calling attention. Although this rule has been printed at the head of the department for the past six months, we receive between the 17th and 25th of every month letters intended for publication in the next issue, and which we ourselves very much desire to print; most of these are unavailable for use in future issues. We earnestly request our readers, therefore, to keep in mind our mechanical restrictions and favor us with their communications early enough for them to be used in season. We also invite any and all readers to contribute to this department—to "tell their troubles" to the other readers freely and look to each other for assistance and helpful suggestions.

DESIGN AND CONSTRUCTION OF SMALL DYNAMOS AND MOTORS.

BY CECIL P. POOLE.

Mechanical Details.

As in laying out the electrical and magnetic proportions of a machine, the working out of mechanical details of construction is best begun with the armature. In the multipolar machines covered by these articles, it is intended that the armature discs shall be clamped together by means of two end-plates and four bolts passing through holes in the core and the end plates. The plates are to have flanges, as indicated in Fig. 15. In the bipolar machines, these flanges and the ventilating holes are omitted, leaving the end-plates simple discs, which are clamped by two nuts on the shaft. The dimensions of the end-plates are given in Table XII. Table XIII gives constants by means of which the diameter of the central hole in the armature core may be determined. Subtracting the value of K_0 from the diameter of the tooth-root circle gives the maximum allowable diameter of the central hole in the armature core discs and end-plates.

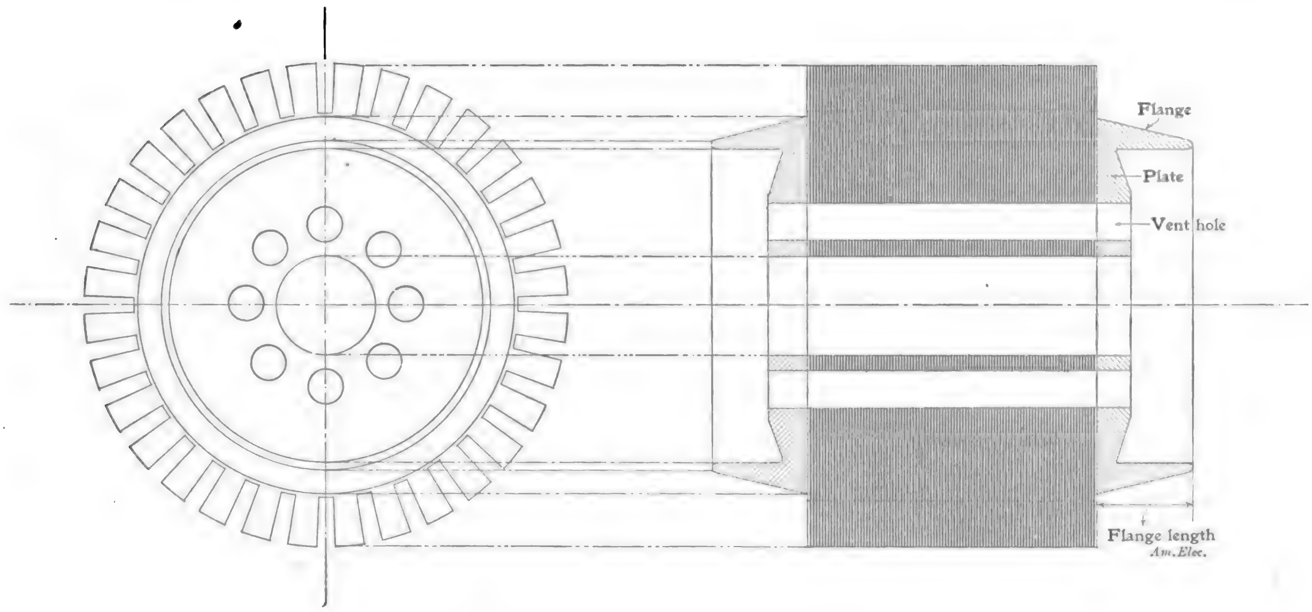

FIG. 15.—ARMATURE CORE CONSTRUCTION.

Besides the central hole, both the discs and the end-plates must have eight ventilating holes of the size specified in Table XII located equidistant and at such distance from the central hole that the edges of the ventilating holes will be ¼ inch from the edge of the central hole. The discs must be keyed to the shaft, and while it is not necessary, the end-plates may be also keyed advantageously. Of course, the key which holds the discs from turning on the shaft would be extended through the end-plates in order to key them, separate keys being unnecessary. The four bolts used for binding the core discs and end-plates together pass through four of the ventilating holes a quarter of a circle apart.

TABLE XII.

Diameter of polar bore =	Up to 8 ins.	8⅛ to 12 ins.	Over 12 ins.
Diameter of vent holes* =	1/2 inch	5/8 inch	3/4 inch
Diameter of core bolts =	3/8 inch	7/16 inch	1/2 inch
End-plate thickness, minimum =	3/8 inch	7/16 inch	1/2 inch
End-plate thickness, maximum =	5/8 inch	11/16 inch	3/4 inch
Flange diameter next to core discs =	1/8 inch less than tooth root circle.	1/8 inch less than tooth root circle.	3/16 inch less than tooth root circle.
Flange diameter at outer edge =	1 1/8 ins. less than tooth root circle.	1 3/16 ins. less than tooth root circle.	1 5/16 ins. less than tooth root circle.

*In all cases, the edges of the vent holes must be 1/4 inch from the edge of the central hole.

Table XIV gives dimensions of the shaft, which is illustrated by Fig. 16. The part indicated by *a* passes through the central hole in the armature core; the part, *c*, through the commutator, and the other parts through the journal boxes. The key seat in the armature part is not shown; its width should be ¼ the diameter of the shaft at *a*, and its length sufficient, of course, to let the key catch all of the core discs (and the end-plates if they are to be keyed). The key should be square, without a head. The core discs must have a key-way punched in the edge of the central hole to fit the key—or more, accurately, to match the key-seat in the shaft. In bipolar machines, each end of the part *a* of the shaft must be screw-threaded for the nuts to clamp the core.

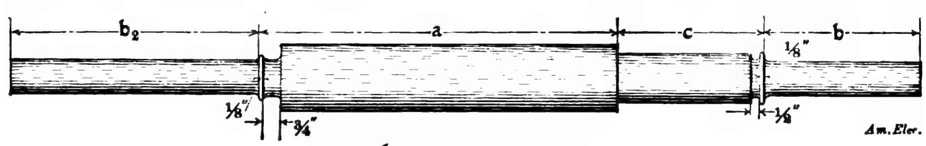

FIG. 16.—ARMATURE SHAFT.

TABLE XIV.
Shaft Dimensions.

Part of shaft (Fig. ..)	*a*	*b*	b_2	*c*
Diameter =	D_0	D_0 — 1/4 in.	D_0 — 1/4 in.	D_0 — 1/8 in.
Length =	Armature core + flanges + 2 ins.	3 D_0 — 1/2 in.	3 D_0 + pulley hub + 1/4 in.	Commutator length over all + 5/8 in.

Note:—D_0 = Diameter of central hole in armature core.

It will be noticed that a groove is turned in the shaft at one end of the part passing through the armature core and another in the far end of the commutator part of the shaft, giving the effect of a rounded collar at the inner end of each of the smallest parts of the shaft. It is important that these grooves be located accurately, for the reason that the collars which they leave on the smaller parts of the shaft are intended to revolve in gaps between the inner ends of the bearing bushings or sleeves and the journal housings, and throw off any oil that may creep along the shaft toward the armature; if the grooves are properly located, the oil will be thrown against the journal housings, and returned to the wells; if they are not, either the shaft will not fit between the bearings or else oil will be thrown off outside of the housings.

Fig. 17 shows the form of journal box recommended by the author. It is of the two-ring self-oiling type, having a brass sleeve or bushing and a split housing. Fig. 17-A is a partly sectional elevation; Fig. 17-B is a part end view and part cross-section on the line $x—y$, except the cap-bolt lugs, which are sectioned on the center line of Fig. 17-A; Fig. 17-C is a partly sectional plan view, the section being on the center line. This box may be used on either a pedestal or a journal bracket of the type in Fig. 18; in the latter case the cap-bolt lugs on the lower half of the housing are unnecessary, the cap-bolts being set into the horizontal arms of the bracket. The bolts would, of course, not need to be as long as specified in Fig. 17; 1¼ inches would be

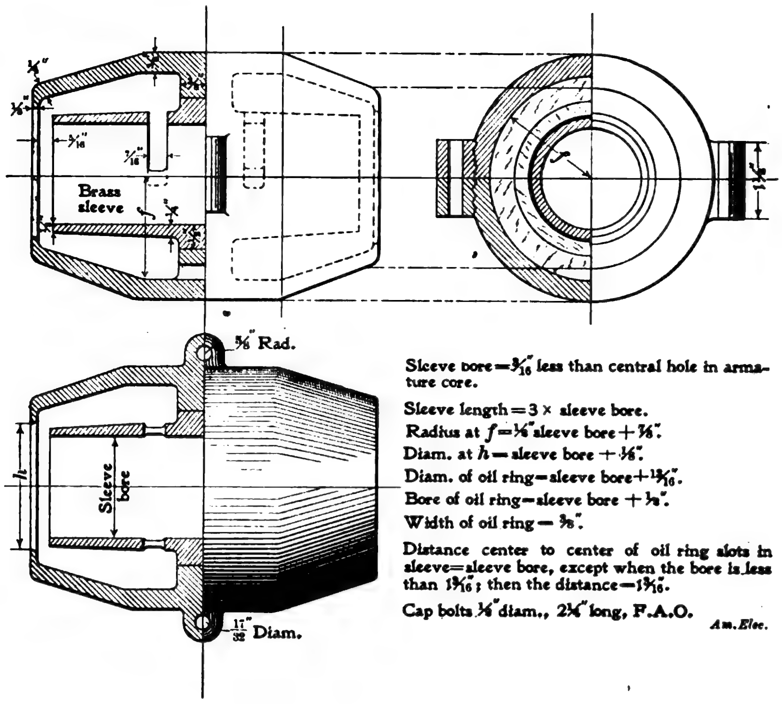

FIG. 17.—JOURNAL BOX AND SLEEVE.

TABLE XIII.

Diam. polar bore.	K_0* 2 poles.	K_0* 4 poles.
3	1 1/2	......
3 1/16	1 1/2	......
3 1/8	1 9/16	......
3 3/16	1 5/8	......
3 1/4	1 5/8	......
3 5/16	1 11/16	......
3 3/8	1 11/16	......
3 7/16	1 3/4	......
3 1/2	1 3/4	......
3 9/16	1 13/16	......
3 5/8	1 7/8	......
3 11/16	1 7/8	......
3 3/4	1 15/16	......
3 13/16	2	......
3 7/8	2	......
3 15/16	2 1/16	......
4	2 1/16	......
4 1/8	2 1/8	......
4 1/4	2 1/4	......
4 3/8	2 5/16	......
4 1/2	2 3/8	......
4 5/8	2 1/2	......
4 3/4	2 9/16	......
4 7/8	2 5/8	......
5	2 11/16	3 1/4
5 1/8	2 3/4	3 5/16
5 1/4	2 7/8	3 3/8
5 3/8	2 15/16	3 7/16
5 1/2	3	3 1/2
5 5/8	3 1/8	3 1/2
5 3/4	3 3/16	3 5/8
5 7/8	3 1/4	3 5/8
6	3 5/16	3 3/4
6 1/8	......	3 3/4
6 1/4	......	3 7/8
6 3/8	......	3 7/8
6 1/2	......	3 15/16
6 5/8	......	4
6 3/4	......	4
6 7/8	......	4 1/16
7	......	4 1/8
7 1/8	......	4 3/16
7 1/4	......	4 3/16
7 3/8	......	4 1/4
7 1/2	......	4 3/8
7 5/8	......	4 3/8
7 3/4	......	4 7/16
7 7/8	......	4 1/2

$$\text{Flange length} = \frac{\text{Armature diam.}}{5}$$

*Subtracting the proper value of K_0 from the tooth-root circle diameter leaves the maximum diameter allowable for the central hole in the armature core.

TABLE XIII, Continued.

Diam. polar bore.	K_0* 4 poles.	K_0* 6 poles.
8	4 9/16	4 1/4
8 1/8	4 7/8	4 1/2
8 1/4	4 15/16	4 9/16
8 3/8	5	4 5/8
8 1/2	5 1/16	4 11/16
8 5/8	5 1/8	4 3/4
8 3/4	5 3/16	4 3/4
8 7/8	5 1/4	4 13/16
9	5 5/16	4 7/8
9 1/8	5 3/8	4 7/8
9 1/4	5 7/16	4 15/16
9 3/8	5 1/2	5
9 1/2	5 1/2	5 1/16
9 5/8	5 9/16	5 1/8
9 3/4	5 5/8	5 3/16
9 7/8	5 11/16	5 1/4
10	5 3/4	5 5/16
10 1/8	5 13/16	5 5/16
10 1/4	5 7/8	5 3/8
10 3/8	5 15/16	5 7/16
10 1/2	6	5 1/2
10 5/8	6 1/16	5 1/2
10 3/4	6 1/8	5 9/16
10 7/8	6 3/16	5 5/8
11	6 1/4	5 11/16
11 1/8	6 5/16	5 3/4
11 1/4	6 3/8	5 13/16
11 3/8	6 7/16	5 7/8
11 1/2	6 1/2	5 7/8
11 5/8	6 1/2	5 15/16
11 3/4	6 9/16	6
11 7/8	6 5/8	6 1/16
12	6 3/4	6 1/8
12 1/8	7 1/16	6 3/8
12 1/4	7 1/8	6 1/2
12 3/8	7 3/16	6 1/2
12 1/2	7 1/4	6 9/16
12 5/8	7 5/16	6 5/8
12 3/4	7 3/8	6 11/16
12 7/8	7 7/16	6 3/4

In machines of 13 to 16 inches polar bore, the shaft and central hole may be made 2 1/2 inches in diameter.

Flange length = armature diameter divided by	5	7

*Subtracting the proper value of K_0 from the tooth-root circle diameter leaves the maximum diameter allowable for the central hole in the armature core.

sufficient. The journal housing is to be made of cast-iron, of course. The sleeve

FIG. 18.—RING BRACKET.

may be held in place by two dowel pins, one set into a hole in the central web of the lower part of the housing and the other in

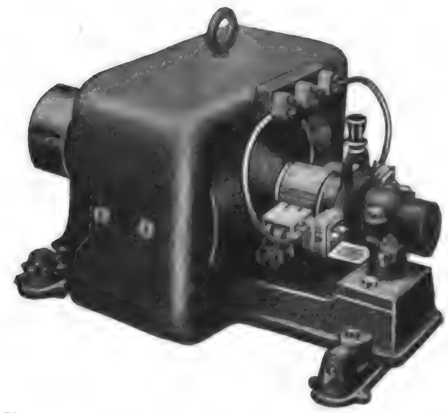

FIG. 19.—BOX YOKE AND PEDESTAL JOURNAL MOUNTING.

a hole in the web of the cap with a driving fit. The pins should fit snugly in diametric-

FIG. 19-A.—PREFERRED FORM OF JOURNAL PEDESTAL.

ally opposite holes in the sleeve web; these holes should not go through the wall of the sleeve. If the builder prefers not to split

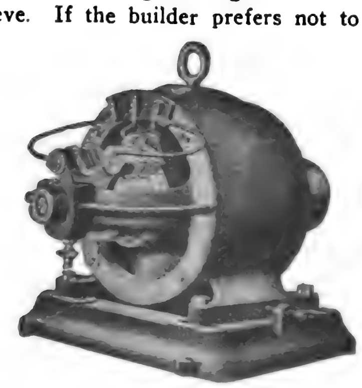

FIG. 20.

the housing but to cast it in a single piece, the box design here shown can be used by making the hole, *h*, at one end of the hous-

ing just 1 inch larger than the bore of the brass sleeve; the hole at the other end should be as stated on the drawing. The larger of these two holes should be at the end of the box farthest from the armature,

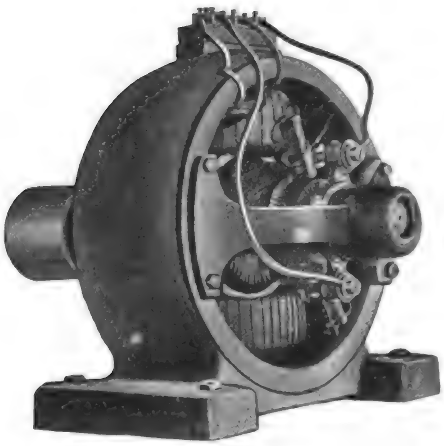

FIG. 21.—CIRCULAR YOKE WITH ARM BRACKET.

the smaller hole being next to the armature at the pulley end and next to the commutator at the other end of the shaft.

The form of journal mounting to use depends primarily on the type of field-magnet

FIG. 22.—SEPARATE BASE AND PEDESTALS.

yoke that is used, and secondarily on the pattern-making ability of the builder. If the box-type of magnet yoke is used, the pedestal form of mounting is the easiest to make, all things considered; see Fig. 19.

FIG. 23.—PEDESTAL MOUNTED ON EXTENSION OF FRAME.

With a circular magnet yoke, either the pedestal or the bracket form may be used, and the bracket form may be fitted to the yoke by means of a continuous ring, as in Fig. 20, or it may be merely a horizontal yoke, bolted to two machined surfaces on the edge of the magnet frame, as in Fig. 21. The ring bracket is much easier to fit accurately to the yoke ring, but it takes a little more material and a trifle more machine work. The bracket in Fig. 21 may also be used with the box-type yoke. The pedestal form may be set on a distinct base, on which the magnet frame is also bolted, as in Fig. 22, or it may be set on an extension cast solidly with the yoke ring, as in Fig. 23. The former is easier to build, but more expensive in material and machine work.

It is impracticable to give dimensions for the arms, webs, walls, etc., of brackets and pedestals of all sizes, but it will probably be of assistance to the amateur to say that arms should be ½ inch to ⅝ inch thick in the center tapering to ¼ inch at the edges; webs and stiffening ribs may be made ⅜ to ½ inch thick where they join the main casting, tapering to 3-16 inch thick at the free edge (or ¼ inch in the center, in the case of a web joining two other members); walls may be from ⅜ to ⅝ inch thick, according to the size of the casting and mechanical stress on the wall.

Commutator and brush-holder construction will be covered in a subsequent article.

BABCOCK BRIDGING TELEPHONE.

BY W. S. HENRY.

The accompanying diagram illustrates a modification of the regular bridging telephone circuit, made by G. Babcock for the Stromberg-Carlson Telephone Manufacturing Company. The principal feature of the modification consists in the interposition of a condenser in the receiver circuit. When the receiver is off the hook the voice current must pass through the condenser, but on account of the high frequency of this current, the condenser increases the impedance of the circuit very little. When the receiver is placed on the hook, the condenser is short-circuited and the bell bridged across the line wires, as in the ordinary bridging instrument. But, if the user forgets to hang the receiver on the hook when through talking, the other bells on the line can still be rung, which would not generally be the case with regular bridging instruments. When the receiver is left off the hook in the arrangement shown in this figure, most of the ringing current would be forced through the bells in the other instruments and hence ring them. This is due to the fact that the frequency of the ringing current is low enough to make the impedance of the circuit containing the condenser very large in comparison with that of bells bridged directly across the line circuit. This arrangement is intended for party line instruments, especially for rural party lines to which more subscribers are connected than to the usual city party line. The condenser should have a capacity of about one microfarad, although one-half microfarad condensers are quite extensively used for this purpose.

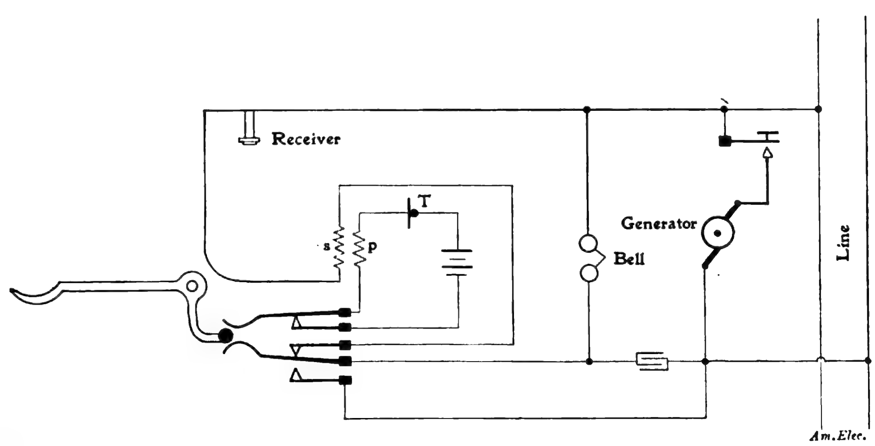

FIG. 1.—BABCOCK BRIDGING TELEPHONE.

ELECTRICAL THAWING OF FROZEN WATER PIPES.

BY C. F. HARDING.

One of the simplest and most useful applications of electricity of recent origin has been in the thawing of frozen water pipes. In most cases water pipes are placed in inconvenient places, requiring costly excavations, or unsightly openings into woodwork or plaster, in order to thaw them by the usual methods. By the application of electricity, however, the work is done in the minimum time without any excavating, leaving the pipe in exactly the same condition that it was before the water in it froze.

The first problem that required the writer's attention was a line of 1½-in. pipe in a hot water heating system which had been allowed to freeze under the floor of a street railway waiting room. The pipe line was about 60 feet in length, and inaccessible, the building having no cellar. The most convenient electric current available for thawing purposes was on the 625-volt trolley circuit.

In order to obtain a good connection between the 300,000 cir. mil cable used and the frozen pipe, the former was soldered into a short nipple, forming part of the radiator connection. This cable was connected to the track. A line from the trolley wire was similarly connected to the other outlet of the same pipe line in series with a water rheostat, a 500-ampere switch and an ammeter. In this case 400 amperes

was applied for the space of about an hour.

Another and much more difficult problem was the thawing of a 2½-in. pipe line 700 feet long connecting a stand pipe with the house supply. This line consisted of a 40-foot vertical section, *A B* (see Fig. 1), of pipe leading to a tank plus the section, *B C*, placed two feet below the surface.

The vertical section was frozen to a height of 40 ft. above the ground, while the horizontal section had been solidly frozen in the ground for a week. The only available current was supplied by a 25-kw. transformer used for lighting the house, and this was placed in such an inaccessible spot that no rheostat could be safely operated in its 2200-volt primary circuit. The primary rheostat method is, in the writer's opinion, the proper one for regulating the thawing current, on account of the small space required, but in this case the more bulky secondary rheostat had to be used.

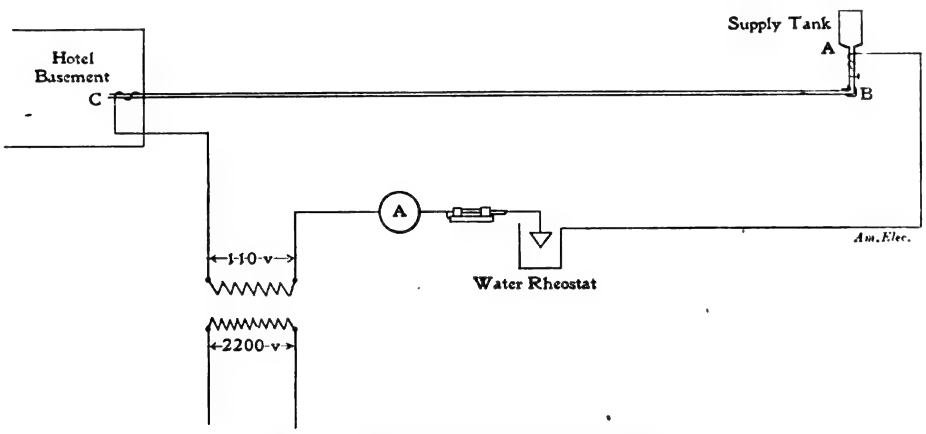

FIG. 1.—THAWING FROZEN WATER PIPE.

The pipe was soon connected to the secondary 110-volt terminals of the transformer in series with the water rheostat, switch and ammeter, by means of lengths of No. 00 cable. The current on the pipe line was gradually increased by means of the rheostat to 270 amperes, at which value it was allowed to remain for about two hours. At the end of this time the vertical section had been thawed as well as the ground in a belt two inches in width surrounding the pipe, although no water flowed in the pipe under a 50-ft. head. The circuit was opened together with the valves in the pipe line, and the heat already imparted to the ground surrounding the pipe soon brought about the desired result, and the water supply was again available.

Although the cost of power in these two cases would, at first thought, seem prohibitive, in order to give this method due consideration, one must balance this expense against the expense of excavating 1300 ft. of frozen ground in the latter case or the tearing down of the under-pinning and the excavating in order to reach the pipe in the former case.

Thus the electrical method of thawing water pipes has to its credit the arguments of economy, facility and celerity, and should, in the future, not only prove profitable to the central station or the plumber, but should also protect the consumer against excessive expense and inconvenience during the dreaded winter season.

REFILLING AND REPAIRING COMMUTATORS.

BY ARTHUR B. WEEKS.

The following experience should be of value where commutator shells are to be refilled, and proves the truth of the oft-repeated statement that the best of material is none too good for a commutator. The writer recalls an instance where not enough pains were taken to ascertain the quality of the copper used in the commutator. The refilled commutator cost one-half the regular price. It appeared all right, was forced to place on the shaft, connections made, and then the trouble began.

As soon as heat was applied through the soldering iron, the made-up mica segments softened, shellac oozed all around the commutator, and the bars fell in, making a most uneven surface. However there was nothing then to be done but to finish the soldering. The commutator nuts were, therefore, tightened all around, and the armature placed in an oven, to bake the shellac dry. This done, the commutator was turned in a lathe.

It would naturally be supposed that this treatment would end the trouble; however, such was not the case, for as soon as the armature was put into the motor it sparked badly. No amount of sandpapering or trueing up, adjustment of holders, changing of brushes, or grinding in brushes, would stop the sparking. In a couple of days, the commutator was so uneven that it was taken out and again turned. The bars were found to be cast, and were very soft. Inside of a week the commutator was entirely worn out.

This experience was very costly, and opened one's eyes to the necessity of securing drop forged or hard drawn copper bars and proper mica segments.

It might be thought that a mistake had been made by the company in using the wrong mica; but a letter from their agent stated that our armature man must have used a blow torch on the comutator to have caused such results, thereby waiving all responsibility in the matter.

For the information of armature repair men not familiar with the different makes of prepared mica, it may be added that commutator mica plate is treated so that there is the merest show of sealing cement, even when subjected to heat. For this reason, a commutator should retain its shape after the leads have been soldered in. Built up mica plate for rings, of some makes, can be cut out of the pasted mica and heated and put under pressure, to form the desired bevel. When ready, it should be baked sufficiently to drive out all moisture.

There is also another flexible mica consisting of two or more layers of sheet mica and a certain cement that will not dry out in a reasonable length of time. This is used by some in making up armature coils, in addition to other insulating materials used. A great deal is claimed for such made-up coils, but it is said they will not withstand much vibration. When new, they will withstand high voltages, but they are short-lived. Where there is the slightest chance for vibration, mica will separate and finally pulverize, and this marks the end of the armature. A good black insulating paint, fish paper and oil paper form probably the best application for railway motors, with a cotton tape over all. Practice varies according to the voltage of the system.

Nowhere is it more important that good mica and good shellac or other varnish be used than in commutator work. Amber mica is most commonly used for commutator segments, as it is softer than white India mica and wears away with the bars. White India is apt to be so hard that the bars wear more rapidly, causing high spots, with consequent sparking, and other bad results.

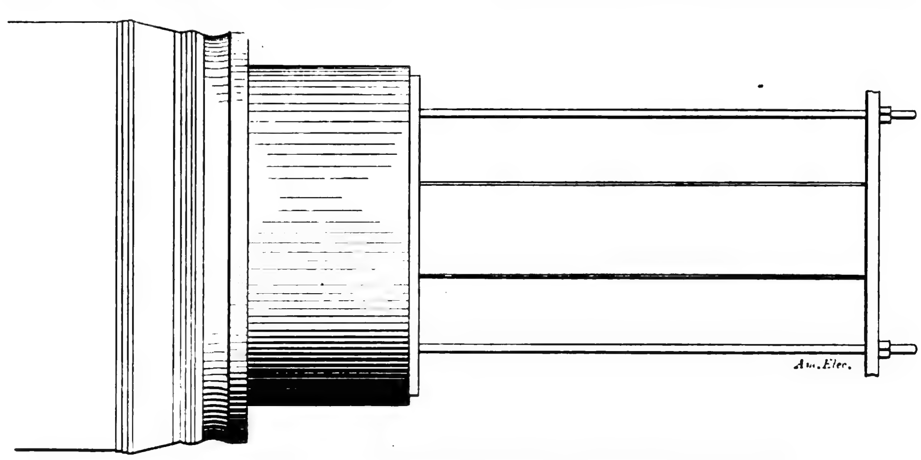

FIG. 1.—METHOD OF REMOVING END COMMUTATOR LOCKING RING.

A good, soft white mica for commutator segments is rare; pasted mica or built up mica being used altogether for this class of work. It is bought by the pound. Prepared mica of the proper thickness can be purchased in sheet form, and segments of the desired shape cut out for any and all repair work. It has often been required to repair a place in a commutator between bars, where the mica may have been burned out, often because of an open circuit in a coil. The wire to a commutator segment is often broken, causing such troubles. After attending to the broken wire, a defect like this is often repaired by filling the

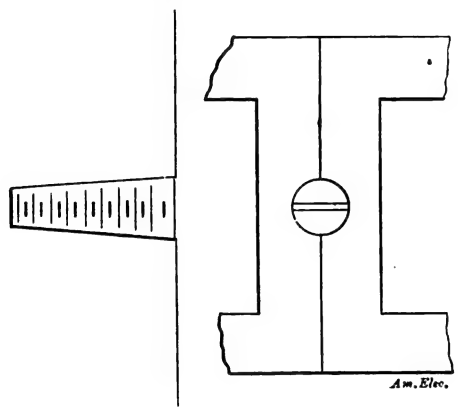

FIG. 2.

cavity (after a thorough cleaning out) with alcohol shellac and pulverized mica, or alcohol shellac and plaster of paris. In small, smooth cavities, this will not stick, and the next best plan is to insert a new mica segment—a simpler operation than is generally supposed.

To do this, the armature is removed from the frame, the nuts loosened which clamp the segments in place, and the end commutator ring removed. The bars affected are pulled back, the old material removed and all mica scraped from the bars. A little shellac or similar lac should be used on the bars, and the new mica segments inserted. The method of removing the end commutator locking ring is familiar to the older men in the work. If there are no holes drilled in this ring diametrically opposite each other, into which bolts can be screwed, such holes must be drilled and tapped. The size of bolts depends upon the

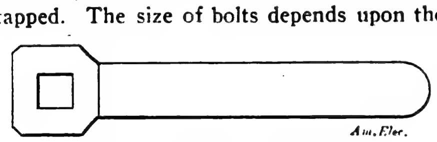

FIG. 3.—SPECIAL WRENCH.

size of commutator. Screw the two bolts into the ring and place a flat piece of iron across the end of the shaft, with holes in the strap for the bolts to pass through. After the lock nuts are removed from the bolts, screw down on the nuts of the two bolts mentioned. After a little effort, the ring will come out. Tap it lightly with a hammer, and see that the ring comes up equally all around, and avoid binding.

There is a style of locking ring which is screwed on, instead of being secured with bolts. In this case, a spanner wrench must be procured, fitting into holes in the ring. After a couple of good, smart blows on the wrench with a hammer, the ring will usually start. When the prongs are bent out of shape, the tool should be dressed, otherwise the holes are liable to be ruined, and it will be next to impossible to get the wrench to hold. Make the mica segments for repair work of this kind just a little larger than the original, especially on the top face, for the ring may not go back in place exactly as when first assembled. With care, it will not be necessary to turn the commutator after this operation. Do not separate any of the bars not affected, for the chances are that if this is done, the commutator will require turning. Cut away the twine or binding wire back of the commutator, should it interfere with the work. Cutting or unsoldering the armature leads will not be necessary, excepting in case of large armatures, where the leads are too large to be bent back. Disconnecting is in these cases the only alternative.

This method of removing and replacing mica is applicable to the copper segments as well. This is often necessary in street railway commutator repairs, when a bar or bars become so highly discolored as to become soft. They are made thus at times, when an armature is grounded, and continued attempts to "make the thing go" send so much current through the bars directly, as the armature will not turn, that there is an intense heat under the brushes, and they glow like an arc light. Coils are very liable to be burned out at the same time. A voltmeter test will indicate the condition of the insulation.

There is a little trick not commonly known, to prevent side play, when lost motion has once set in between two surfaces, such as in a ring armature, where the laminations or core have worked loose on the hub or spider. A good method of repair, and one that can be effected in a very short time, and made to stay, has puzzled many. The method is illustrated by Fig. 2 herewith.

Turn up in a lathe a taper bolt, cutting a regular gas pipe thread thereon. Make the bolt headless; get the size of the hole to be drilled by means of thread calipers, at about halfway of the tap. Then when the two surfaces are in their original position, drill and tap the hole. Try the bolt from time to time in the hole. Run the bolt just below the surface, and rivet over the metal with a hammer, so that under no circumstances can the bolt back out. A favorite method with machine hands is to prick-punch in several places around the bolt head, at the intersection of the bolt and hole. The only objection to this plan is that should it be necessary to replace a bolt, it is next to impossible to withdraw it. It is often necessary to drill the bolt out.

If it is required to remove the bolt, by merely setting the metal over it, the metal can be cut away with a small, sharp cold-chisel; then use a large screwdriver, which is best made of a ½ to ⅝ square piece of steel, and use a monkey wrench or special wrench.

To drill out such a headless bolt or screw, where it is impossible to get the drill in a center made with a prick-punch, it is necessary to fill the slot in the screw to obtain a center. Fit a piece of iron into the slot, center it and drill. Sometimes a bolt is best removed by drilling a hole therein part way, then driving a square tool into the hole, then by means of a wrench as before described, back out the screw. The tool should be slightly tapered, and large enough to drive very tightly into the hole.

When this method fails to remove a bolt, use a drill as large as possible, and run it to the bottom of the hole. Center the drill exactly, and take care not to cut away any of the thread. Nothing but the shell of the bolt now remains. Use some sort of pry to loosen this shell, which can be easily removed. A tap should then be run into the hole to smooth it.

SWITCHBOARD CONNECTIONS OF COMPOUND-WOUND GENERATORS.

BY H. M. GASSMAN.

Judging from the number of mistakes which are made in connecting compound wound generators to switchboards, very few men seem to have a clear understanding of the correct scheme of connections. The reason for this is due to a great extent to the confusion caused by introducing the idea of polarity when speaking of the terminals of a generator.

The writer finds it advantageous to drop the idea of polarity, and speak of three leads running from the generator as

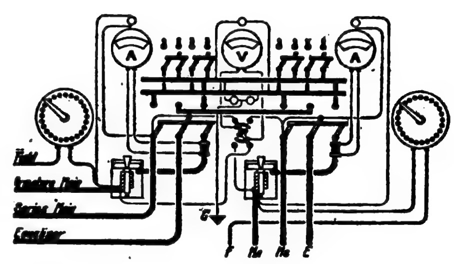

FIG. 1.—SWITCHBOARD CONNECTIONS OF COMPOUND-WOUND GENERATORS.

"equalizer," "armature" and "series" main. The "armature" main is the one running direct from the armature terminal to the switchboard, and the "series" main the one running direct from the series coil. Whatever the polarity of the "series" main, the "equalizer" will be of the same polarity and the "armature" main of the opposite polarity.

Further, the scheme of connections is not changed, even though the polarity of the generator be reversed (except that meter leads will have to be reversed to give the right deflection on the scale).

The ammeter and circuit breaker *must always* be connected in the "armature" main.

The "series" main may be connected to the ground feeder or to the line feeder. If the equalizer is not run to the switchboard the equalizer switch is mounted on a pedestal near the generator.

When the "series" main is connected to

the ground, there may be quite a saving in cable if the connection be made direct to the ground feeder without going to the switchboard. In this case the circuit breaker must be connected in series with the armature between the armature and the equalizer terminal. This circuit breaker and the equalizer switch would then be mounted on a panel near the generator. No circuit breaker on the switchboard would then be required.

When the "armature" main is connected to the ground, it must be run first to the switchboard before making the ground connection, in order to reach the ammeter, unless the ammeter shunt be located near the generator, in which case an auxiliary panel having the circuit breaker and an equalizer switch could be located near the generator and the same saving of cable be made.

It is very desirable to have the "series" main connecting to the feeders in railway plants where lightning is liable to do damage. In case the lightning arrester is inoperative, the lightning would not damage the armature, as it would not reach it, because of the self-induction of the intervening series coil. For this reason largely the majority of electrical manufacturers have recommended that their machines be so connected.

So far in this discussion the matter of polarity has been of no consequence, but for sake of uniformity it is desirable that it be made to conform to the almost universal practice of making the line feeders positive. Plants have been run intentionally and unintentionally with the feeders negative. The writer has never found a satisfactory explanation of why the positive polarity was adopted rather than the negative. This question probably was decided in the same way that 110 volts was determined as the standard for incandescent lighting.

If the polarity of a generator does not agree with the polarity desired on the feeders, it is a very easy matter to reverse the polarity of the generator simply by magnetizing the fields in the opposite direction.

CHANGING MAGNET WINDINGS FOR DIFFERENT VOLTAGES.

One frequently has occasion to rewind a magnet coil for some voltage other than the one for which the magnet was originally wound, keeping the magnetizing power of the coil practically unchanged. While the formula for calculating the size of wire to be used in the new winding is not at all complex, the calculation is a little tedious because of the number of figures contained in the number of circular mils of wire cross-section. Moreover, if standard sizes of wire are to be used, it is usually impossible to make the new size of wire fit the new voltage accurately. In view of this latter feature, results just as satisfactory in practice can be obtained by means of the accompanying set of "scales" as by the most elaborate calculation. The scales are based on the average relation between the cross-sections of successive sizes of copper wire drawn to B. & S. gauge; the average ratio of one cross-section to the next larger one in the list of gauge numbers is 0.793, and the scales are computed for voltages of the same ratio between successive values in the downward (decreasing) direction.

For use, the group of voltage scales should be cut out and pasted on a piece of extra-heavy cardboard, and the wire scale cut out and pasted on a thin but substantial piece of cardboard or a very heavy piece of drawing paper. The scale of wire sizes can then be set against any one of the voltage scales with the scale divisions matching. In order that the scales may be cut out without spoiling the page on the other side of this leaf, they have been reproduced on page 120. The following examples will serve to make use of the scales clear to those unfamiliar with the principle on which they are based:

Voltage Scale. A	Voltage Scale. B	Voltage Scale. C	Voltage Scale. D	Voltage Scale. E	Voltage Scale. F
1.94	2.02	2.14	2.23	2.32	2.42
2.45	2.55	2.69	2.81	2.93	3.05
3.09	3.21	3.40	3.55	3.69	3.85
3.89	4.05	4.28	4.47	4.66	4.85
4.9	5.1	5.4	5.65	5.9	6.2
6.2	6.5	6.8	7.1	7.4	7.7
7.8	8.1	8.6	9.0	9.4	9.8
9.9	10.3	10.8	11.3	11.8	12.3
12.4	12.9	13.7	14.4	14.9	15.5
15.7	16.3	17.2	18.0	18.7	19.5
19.7	20.5	21.7	22.7	23.6	24.6
24.9	25.9	27.4	28.6	29.8	31.1
31.4	32.6	34.5	36.1	37.6	39.2
39.6	41.2	43.5	45.5	47.4	49.4
50.0	52.0	55.0	57.5	60.0	62.5
63.0	65.5	69.0	72.5	75.5	78.5
79.5	82.5	87.5	91.0	95.	99.
100	104.	110.	115.	120.	125.
126.	131.	139.	145.	151.	157.
159.	166.	175.	183.	190.	198
201.	209.	221.	231.	240.	250.
253.	263.	278.	291.	303.	315.
319.	332.	351.	367.	382.	397.
402.	418	442.	463.	481.	500.
507.	528.	558.	583.	607.	*Am. Elec.*

Wire Sizes.
2
3
4
5
6
7
8
9
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A magnet winding of No. 23 wire intended for 115 volts terminal e.m.f. is to be displaced by a winding for 6-volt battery current. Set the wire scale against voltage scale *D* with No. 23 opposite to 115 volts; there is no 6-volt value in the scale, 5.65 volts being the nearest number; opposite this is found No. 10, which is the size of wire to be used. Keeping the scales set as described, it will be found that the following windings are possible: No. 15 wire for 18 volts, No. 17 wire for 27 volts, No. 26 wire for 230 volts, and so on.

Again, suppose a winding of No. 14 wire for battery current of 6 volts is to be substituted by a winding for 120 volts. Setting the wire scale against voltage scale *A*, with No. 14 opposite 6.2, one finds that No. 27 wire is suitable for 126 volts; but 126 volts are not available, so that scale *E*, which includes 120 volts exactly, should be used. Setting No. 14 opposite 5.9 in scale *E*, No. 27 is found opposite 120 volts, so that the first result was correct even though the scale values were not exact. It will usually be found best, however, to use the voltage scale which contains the exact value of one of the voltages with which one is dealing.

It should be remembered that the insulation on small wire sizes takes up a much larger proportion of the cross-section of a magnet coil than the insulation on large sizes; consequently, a coil of given dimensions wound with small wire will take more *watts* than one wound with large wire, if each is supplied with the proper voltage to give the same ampere-turns as the other. As a result of this, in changing from a low voltage to a higher one, it will be found that the winding for the high voltage heats more than the original winding for the lower voltage. When it is possible, therefore, the length of the new magnet coil parallel with the core should be made greater than that of the original coil, when the winding is changed to a higher voltage. The relation between the length of the new coil and that of the original one should be approximately as follows:

$$L_n = \frac{E_n\, d^2_n}{E_0\, d^2_0} \times L_0$$

in which L is the length of coil along the core, E is the voltage, and d is the diameter of wire *over its insulation;* the subscripts n and o indicate, respectively, the new and old values. It is, of course, unnecessary to make any change in the length of coil when changing to a voltage that is lower than the original voltage. In this case the new winding will heat less than the old one.

To get more Heat from a Radiator.—The electric fan that is used to keep one cool during the summer can also be used advantageously to heighten the temperature of a room during the winter, where the steam radiator is either too small or the steam pressure too low to maintain a comfortable temperature. Place the fan so that the current of air will blow against a large surface of the radiator and in a very short while the room is changed from cold to warm.

AVERAGE LENGTH PER TURN OF WIRE IN MAGNET COILS.

In order to determine the exciting power of a magnet coil taking current at a stated voltage, it is necessary to know the average length per turn of wire in the coil. For round coils—that is, coils wound on a bobbin or former of circular cross-section—the mean length per turn is equal to π times the sum of the bobbin diameter + the coil depth. If the bobbin or former on which the coil is wound be made 1/8 inch larger in diameter than the magnet core, sufficient mechanical clearance will be obtained for all ordinary conditions. The accompanying table is computed on this basis, and will be found extremely useful in connection with magnet windings for round cores. It should be kept in mind that the "Core diameter" in the table is the *magnet* core diameter, not that of the bobbin.

TABLE I.

Mean Length per Turn of Wire in Round Magnet Coils.
Diameter of Coil Bobbin to be 1/8-inch Larger than Magnet Core.

Core diam. + coil depth.	Mean length per turn; inches.	Core diam. + coil depth.	Mean length per turn; inches.	Core diam. + coil depth.	Mean length per turn; inches.	Core diam. + coil depth.	Mean length per turn; inches.
3/4	2.75	4 1/2	14.55	8 1/4	26.5	12	38.3
13/16	2.95	4 9/16	14.75	8 5/16	26.7	12 1/16	38.5
7/8	3.15	4 5/8	14.95	8 3/8	26.9	12 1/8	38.7
15/16	3.34	4 11/16	15.15	8 7/16	27.1	12 3/16	38.9
1	3.54	4 3/4	15.35	8 1/2	27.3	12 1/4	39.1
1 1/16	3.73	4 13/16	15.55	8 9/16	27.5	12 5/16	39.3
1 1/8	3.93	4 7/8	15.75	8 5/8	27.7	12 3/8	39.5
1 3/16	4.13	4 15/16	15.95	8 11/16	27.9	12 7/16	39.68
1 1/4	4.32	5	16.15	8 3/4	28.1	12 1/2	39.85
1 5/16	4.52	5 1/16	16.35	8 13/16	28.3	12 9/16	40.05
1 3/8	4.72	5 1/8	16.55	8 7/8	28.48	12 5/8	40.25
1 7/16	4.91	5 3/16	16.75	8 15/16	28.65	12 11/16	40.45
1 1/2	5.11	5 1/4	16.95	9	28.85	12 3/4	40.65
1 9/16	5.31	5 5/16	17.15	9 1/16	29.05	12 13/16	40.85
1 5/8	5.5	5 3/8	17.35	9 1/8	29.25	12 7/8	41.05
1 11/16	5.7	5 7/16	17.55	9 3/16	29.45	12 15/16	41.25
1 3/4	5.9	5 1/2	17.75	9 1/4	29.65	13	41.45
1 13/16	6.09	5 9/16	17.95	9 5/16	29.85	13 1/16	41.65
1 7/8	6.29	5 5/8	18.15	9 3/8	30.04	13 1/8	41.85
1 15/16	6.48	5 11/16	18.35	9 7/16	30.24	13 3/16	42.03
2	6.68	5 3/4	18.55	9 1/2	30.43	13 1/4	42.2
2 1/16	6.88	5 13/16	18.75	9 9/16	30.63	13 5/16	42.4
2 1/8	7.07	5 7/8	18.95	9 5/8	30.82	13 3/8	42.6
2 3/16	7.27	5 15/16	19.15	9 11/16	31.	13 7/16	42.8
2 1/4	7.46	6	19.35	9 3/4	31.2	13 1/2	43.
2 5/16	7.66	6 1/16	19.55	9 13/16	31.4	13 9/16	43.2
2 3/8	7.86	6 1/8	19.75	9 7/8	31.6	13 5/8	43.4
2 7/16	8.05	6 3/16	19.95	9 15/16	31.8	13 11/16	43.6
2 1/2	8.25	6 1/4	20.15	10	32.	13 3/4	43.8
2 9/16	8.45	6 5/16	20.35	10 1/16	32.2	13 13/16	44.
2 5/8	8.64	6 3/8	20.55	10 1/8	32.4	13 7/8	44.2
2 11/16	8.84	6 7/16	20.75	10 3/16	32.6	13 15/16	44.4
2 3/4	9.04	6 1/2	20.95	10 1/4	32.8	14	44.6
2 13/16	9.23	6 9/16	21.15	10 5/16	33.	14 1/16	44.78
2 7/8	9.43	6 5/8	21.35	10 3/8	33.2	14 1/8	44.95
2 15/16	9.62	6 11/16	21.55	10 7/16	33.4	14 3/16	45.15
3	9.82	6 3/4	21.75	10 1/2	33.6	14 1/4	45.35
3 1/16	10.02	6 13/16	21.95	10 9/16	33.8	14 5/16	45.55
3 1/8	10.21	6 7/8	22.15	10 5/8	34.	14 3/8	45.75
3 3/16	10.41	6 15/16	22.35	10 11/16	34.2	14 7/16	45.95
3 1/4	10.61	7	22.55	10 3/4	34.4	14 1/2	46.15
3 5/16	10.8	7 1/16	22.75	10 13/16	34.6	14 9/16	46.35
3 3/8	11.	7 1/8	22.95	10 7/8	34.78	14 5/8	46.55
3 7/16	11.2	7 3/16	23.15	10 15/16	34.95	14 11/16	46.75
3 1/2	11.39	7 1/4	23.35	11	35.15	14 3/4	46.95
3 9/16	11.59	7 5/16	23.55	11 1/16	35.35	14 13/16	47.15
3 5/8	11.78	7 3/8	23.75	11 1/8	35.55	14 7/8	47.33
3 11/16	11.98	7 7/16	23.95	11 3/16	35.75	14 15/16	47.5
3 3/4	12.18	7 1/2	24.15	11 1/4	35.95	15	47.7
3 13/16	12.37	7 9/16	24.35	11 5/16	36.15	15 1/16	47.9
3 7/8	12.57	7 5/8	24.55	11 3/8	36.35	15 1/8	48.1
3 15/16	12.77	7 11/16	24.75	11 7/16	36.55	15 3/16	48.3
4	12.96	7 3/4	24.94	11 1/2	36.75	15 1/4	48.5
4 1/16	13.16	7 13/16	25.14	11 9/16	36.95	15 5/16	48.7
4 1/8	13.36	7 7/8	25.33	11 5/8	37.15	15 3/8	48.9
4 3/16	13.55	7 15/16	25.53	11 11/16	37.35	15 1/2	49.3
4 1/4	13.75	8	25.72	11 3/4	37.53	15 5/8	49.7
4 5/16	13.95	8 1/16	25.92	11 13/16	37.7	15 3/4	50.1
4 3/8	14.15	8 1/8	26.11	11 7/8	37.9	15 7/8	50.45
4 7/16	14.35	8 3/16	26.31	11 15/16	38.1	16	50.85

DRYING OUT MAGNET COILS.

BY W. B. ARTHUR.

The water rheostat is used for many purposes, but the following will be new to many, probably. The tank shown in Fig. 1 is of galvanized iron. Water is let into it at the top in a steady stream, governed by the valve shown. At the bottom of the tank is a pipe about one foot long, also containing a valve; just below this drain pipe is a pan, with outlet through the floor into a drain pipe to the sewer. The tank thus arranged is free to be moved wherever desired after emptying out the water, as no pipes are positively connected to it.

The wires are plainly shown in the illustration. They enter the Edison cut-out in the upper right hand corner of the slate panel, and thence pass to the switch. One wire goes to an iron plate in the bottom of the tank; it could have been connected directly on the tank, somewhere near the top. The other wire is connected to the plate suspended by a rope above the tank, and the amount of current passing is regulated by varying the depth of the plate in the water. From the latter plate the wire goes to a coil of wire on the bench. The other end of the wire from coil is connected to the other side of the switch. See Fig. 2 also.

In every electric light or power plant coils are wound and usually immersed in an insulating varnish of some sort. All

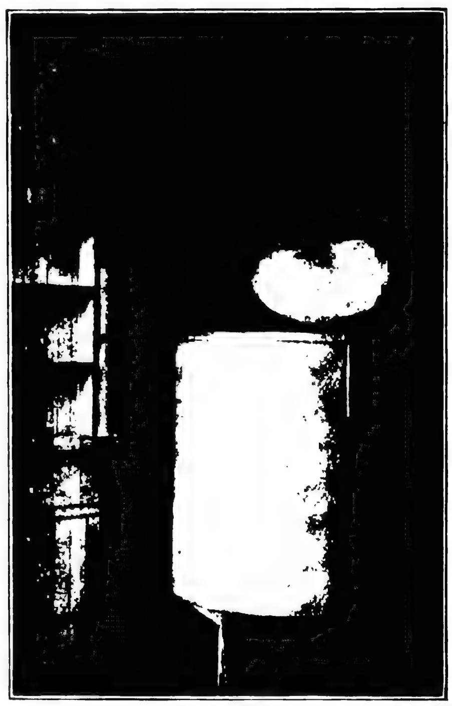


FIG. 1.—WATER RHEOSTAT.

of these produce more or less verdigris, but drying out the coil quickly will reduce objectionable effects very materially, if not altogether obviating them. Steam heat or even heat of any kind does not dry as completely and effectually as does a transmission of electric current through the coil itself. This has been repeatedly and satisfactorily demonstrated. Current can be applied as desired; but if no ammeter is in circuit, one must gauge the temperature of the coil by feeling it. The coil must not be heated too severely at the start, lest it become damaged. It may steam a great deal, and still be all right. A number of similar magnet coils or armature coils, if connected in series will, of course, take the same current, and all can be dried at the same time.

It is customary to dip small coils.. There are several insulating varnishes which, if not baked too long, will still retain their elasticity; but if the baking is stopped too soon, verdigris will surely follow by any

method of drying. A great deal has been said about the elasticity of clear insulating varnishes, but as far as their use on coils for field magnets and armatures is concerned, elasticity does not count for much. The coils should be baked to a deep brown—not a straw color. If one has any doubts about the results of the electric drying, they can be dispelled by trying it on a coil, and at the same time baking another coil in an oven for the standard length of time and at the required temperature. If both are put away on a shelf in a dry place, and examined at the end of three or four weeks or more, the excess of verdigris on the oven-baked coil will be conspicuous.

The current used in the case illustrated was 110 volts alternating. The best practice is to have an ammeter in circuit; none is shown here. A tube thermometer is also greatly advantageous.

Every electric repair shop should have its water rheostat. It is indispensable for

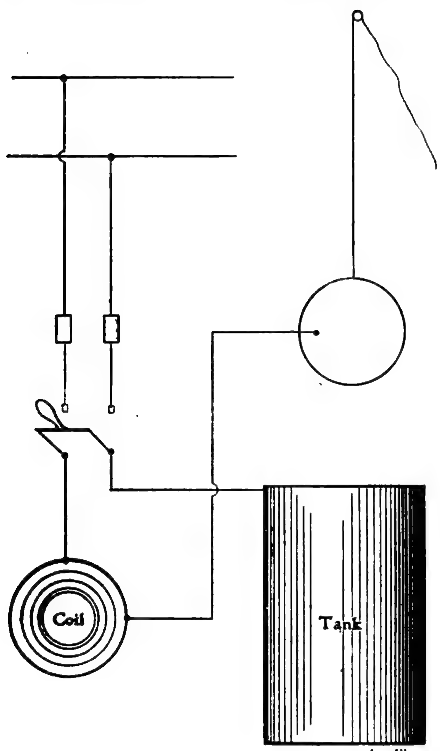


FIG. 2.—DIAGRAM OF CONNECTIONS.

such places. It can be used for testing motors and meters; and one can test a single-phase wattmeter to ascertain the proper connections to be made before connecting the meter on the system, to avoid the cut-and-try method which wastes both time and material. There are men who can do a fine piece of electric wiring for an office or factory, but who do not know how to connect up a wattmeter, especially a two-phase meter. The water rheostat can be used to show the method of connecting.

Referring again to coils dried by current passed through them, it should not be supposed that the interior of the coil has the same color as the exterior—far from it. That is one reason why the baking is not thorough. Moreover, some varnishes which are suitable for cloth and paper are quite unsuited for armature or field magnet coils; special kinds are manufactured for every sort of work.

Principles of Electrical Apparatus

EFFECT OF SELF-INDUCTION IN THE ROTOR OF AN INDUCTION MOTOR.

The rotor of an induction motor is subject to self-induction, just like the armature of a direct-current motor. This effect, however, is greater in degree and more disadvantageous in the induction machine, as will be shown in due course.

The current induced in the rotor conductors by the rotating magnetic field alternates at a low frequency, as explained last month, and as the conductors form closed circuits about an iron core they possess considerable inductance, which results in not only reducing the volume of current flowing, but in throwing that current out of phase with the induced e.m.f. that forces it through the rotor conductors. This phase displacement is illustrated by the diagrams, Figs. 1 and 2, in which a single turn or loop of the rotor "winding" is shown. (It is much easier to follow the actions in the rotor by considering a single loop, and the result is practically as accurate as though the whole squirrel cage were considered. It also simplifies matters to study a bipolar field, and this will be done throughout the Lessons on this subject. The only difference in the actions of bipolar and multipolar fields is in the rotative speed.)

In Figs. 1 and 2 a rotor core is represented having two conductors joined at the ends by wires across the heads, thus forming a closed loop. The inner edge of

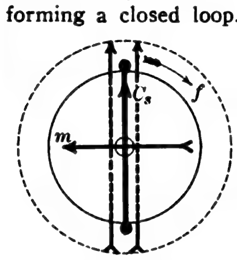


FIG. 1.—CURRENT IN PHASE.

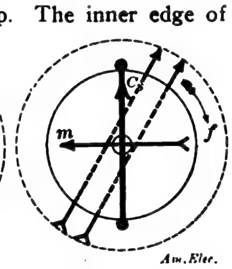


FIG. 2.—CURRENT LAGGING.

the stator ring is indicated by the dotted circle, the air-gap being exaggerated in order to show the action of the rotating field flux. The plane of this flux, as well as the position of its central or densest part, is indicated by double arrows across the air-gap, and the direction of rotation by the curved arrow, *f*. The e.m.f. induced in the loop will have its maximum value when the central zone or densest part of the flux, indicated by double arrows, passes across the conductors of the loop and with no self-induction, the current would also attain its maximum value at this instant, as indicated in Fig. 1, where the arrow-head, C_s, indicates the flow of induced current in the rotor loop. This current induces a cross magnetic-flux in the rotor core, as indicated by the arrow, *m*, and the pull or torque between this and the field flux is greatest when the planes of the two are a quarter of a mechanical cycle apart, as shown; consequently, the torque is maximum when there is no lag in the current.

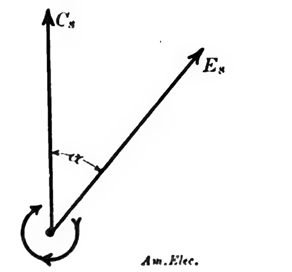


FIG. 3.—ILLUSTRATING LAG ANGLE.

Self-induction, however, produces a lag in the current (the phase of the induced e.m.f. remains coincident with the mechanical phase of the field flux), and then the current in the loop does not attain maximum value until the rotating flux has passed the conductors, as indicated in Fig. 2; then the angle between the field flux and the cross flux is greater, as shown, and the torque is less. The exact relation between the current lag and the torque may be shown by the use of a few simple formulas. As it is awkward to compare the current phase with the position of the field flux in space, the phase of the induced e.m.f., which rises to maximum in unison with the passage of the flux, will be taken as the basis of comparison.

If the difference of phase between the current, C_s, and the e.m.f., E_s, which forces it through the loop be represented by two vectors, as in Fig. 3, the angle, *a*, between the vectors will be such that its cosine is equal to the resistance of the loop divided by its impedance; thus:

$$R_s \div Z_s = \cos a.$$

As stated previously, the torque is maximum when the current is in phase with its e.m.f., and it decreases directly in proportion to the cosine of the angle between the two vectors representing the difference of phase between the current and the e.m.f. Thus, if there were no lag in the current, the torque exerted on one loop, in pound-feet, would be equal to $.707 \times \Phi \times C_s \times k$. In this expression, Φ is the number of magnetic lines in the rotating field flux; C_s is the current in the conductor loop, and k represents the constants necessary to reduce absolute units to practical ones. As there is always a current lag, however, the torque can be represented by the expression: $T = .707\ \Phi\ C_s k \cos a$. As the cosine of the angle of lag is equal to the resistance of the loop divided by its impedance, the last equation may be changed to read:

$$T = .707\ \Phi\ C_s \frac{R_s}{Z_s} k.$$

Furthermore, as the current in the loop is equal to the e.m.f. divided by the impendance, $C_s = E_s \div Z_s$ and as the e.m.f., E_s, is equal to $4.44 \times f_s \div 100{,}000{,}000$, the current, C_s, is equal to $4.44 \times f_s \div 100{,}000{,}000 \times Z_s$, and the equation for pound-feet of torque may be again changed to read thus:

$$T = \pi \Phi^2 f_s \frac{R_s}{Z_s^2} k \ldots\ldots\ldots\ldots (5)$$

in which k now includes also the numerical divisor 100,000,000 (or more accurately its reciprocal) in the expression for e.m.f., and f_s is the frequency of the current in the rotor loop. This formula shows that increasing the resistance of the rotor loop will increase the torque, while any increase in the impedance of the rotor loop will decrease the torque. Now, impedance consists of resistance and reactance combined, so that the resistance cannot be increased without increasing the impedance also, but it must be remembered that the increase in impedance is not directly proportional to the increase in resistance. Separating the impedance into its component parts, formula (5) develops into

$$T = \pi \Phi^2 n_s \frac{R_s}{R_s^2 + X_s^2} k \ldots\ldots (6)$$

A rough example will serve to show that if the resistance equals the reactance, a change in either direction will reduce the torque; consequently, increasing the rotor resistance will increase the torque only up to the point where the resistance and reactance become equal—beyond that, it decreases the torque. Example: Resistance $= 2$; reactance $= 2$; as impedance, Z, is equal to $\sqrt{R^2 + X^2}$, in this case its value is $\sqrt{4+4} = 2.8284$, and the fraction, $\frac{R_s}{Z_s^2}$, in formula (5) has a value of $\frac{2}{8} = 0.25$. Now, suppose the resistance were increased to 2.1; then the impedance would be 2.9 and the fraction $\frac{R_s}{Z_s^2} = \frac{2.1}{8.41} = 0.2497$. Again, suppose the resistance reduced to 1.8; then the impedance would be 2.69, and the fraction $\frac{R_s}{Z_s^2} = 0.2486$. In both cases, the value of $\frac{R_s}{Z_s^2}$ is less than when the resistance and reactance are equal, and the torque increases or decreases directly with an increase or decrease in the value of this fraction.

Formulas (5) and (6) also show that if the other factors remain unchanged, any increase in the frequency, f_s of the rotor current will increase the torque. This confirms the explanation, in the preceding article, of the increase in torque due to increase in "slip," the rotor conductors being "cut" by the magnetic field at a higher rate as the difference between their rotational velocities increases. Following out this line of reasoning, the torque would be maximum when the rotor stands still, as the conductors would be "cut" at the full frequency, f, of the magnetic field.

This would be true if the rotor had no inductance and consequently no reactance. ($X = 2\pi f L$.) But it has, and at standstill the reactance, with ordinary frequencies, may be twenty or thirty times as high as at full speed. This great reactance throws the rotor current so far out of phase with its e.m.f. as to decrease the torque to a very small value, notwithstanding the great rush of current due to the high e.m.f. induced in the rotor by the high rate of "cutting" between the rotating field and the conductors. Another rough example will serve to illustrate this point. Formula (6) shows that the torque is directly proportional to

$$f_s \frac{R_s}{R_s + X_s^2}$$

Now suppose that the resistance, R_s, of the single loop is 0.005 ohm and its inductance, L_s 2½ millihenrys, or 0.0025 henry. With a primary frequency of 60 cycles and a 5 per cent. slip at full speed, the rotor frequency will be $.05 \times 60 = 3$ cycles, and the reactance ($2\pi f_s L_s$) of the one loop will be $2\pi 3 \times 0.0025$, or 0.047124 ohm. Substituting these values in the above expression, we get

$$f_s \frac{R_s}{R_s^2 + X^2} = 3 \times \frac{0.005}{0.000025 + 0.00222} = 6.68$$

so that the torque is $6.68 \pi \Phi^2 k$ at full speed.

At standstill the rotor frequency is the same as the primary frequency—60 cycles. The reactance then will be $2\pi 60 \times 0.0025$, or 0.9425 ohm, and

$$f_s \frac{R_s}{R_s^2 + X_s^2} = 60 \times \frac{0.005}{.000025 + .8883} = 0.3377.$$

Consequently, the torque at standstill will be only $0.3377 \pi \Phi^2 k$ pound-feet, the relation between this torque and the full load torque having the ratio, roughly, of 0.338 to 6.68. It is because of this effect that the rotors of large motors are provided with coil windings and slip rings whereby an external resistance may be inserted in the rotor circuit. Suppose, for example, that the terminals of our single loop were led to two slip rings (like the collector rings on an alternator) and the brushes of those slip rings connected to a resistance of 0.935 ohm; then the total resistance would be 0.94 ohm, the reactance at standstill, 0.9425 ohm, and the starting torque, $31.8 \pi \Phi k$ pound-feet, or nearly 100 times the standstill torque that was obtained without external resistance.

Letters on Practical Subjects

Communications intended for publication in this department must be received at this office not later than the 15th of the month prior to the date of publication.

Charging Storage Batteries.

In response to Mr. Bryan's letter last month inviting discussion on the storage battery, I would say that the voltage per cell should be 2.5 volts before the charging circuit is disconnected and not after; this is explicitly stated in papers issued by the Electric Storage Battery Company.

In experimenting with two Hatch cells, the highest voltage obtainable per cell at normal charging rate was 2.63 volts, which dropped to 2.28 volts on open circuit immediately after charge; on closed circuit it rapidly fell to 2 volts per cell. In the same experiment with a new battery of Chloride accumulators 2.6 volts per cell before disconnecting was all that could be obtained without going beyond the danger point.

As the editor stated, "The voltage is not the only guide to full charge"; if a portable voltmeter with a low-reading scale is not at hand, the density of the electrolyte is a good indication. At full charge it should be 1.200 specific gravity, and the battery should never be discharged below 1.175. To maintain a battery in the best condition and keep a check on its action, records of the voltage and the density of the electrolyte should be kept, by this means any irregularity can be detected almost as soon as it occurs.

The color of the plates is also a guide as to the state of the charge; the positive should be a deep brown, and the negative a light slate color when full charge is obtained. The battery will also gas freely near the end of charge. The last two indications are not as reliable as the first two, which should never be omitted if the instruments (voltmeter and hydrometer) are available.

The foregoing is applicable only to a battery in good condition; the voltage of a battery badly sulphated, or of one that has been overloaded or continually overcharged, cannot be brought up equal to one that has had good care and is free from these faults. Age will also slightly decrease the voltage of a battery.

I have found that the temperature of the battery room has an effect on the voltage of a battery without affecting its efficiency to any great extent. I recently had charge of three batteries of Chloride accumulators, of which two were in rooms where the temperature hardly ever exceeded that of the outer atmosphere; the voltage per cell in these batteries always came up to the standard—2.5 volts. The third battery was in a room, the temperature of which ranged from 90 degs. F. to 104 degs. F. The voltage per cell of this battery never exceeded 2.35 volts with charging current flowing. And in a test of the efficiency of the batteries the latter showed only 0.35 per cent. less than the other two.

I may also state that my experience with men handling storage batteries (which I admit has been limited) is just the reverse of Mr. Bryan's—they were very decided on the particular point in question.

F. SCHROEDER.

Fort Revere, Mass.

Mr. Malcolm's Motor Connections.

I herewith submit a solution (Fig. 1) of the problem in motor connections, which appeared in your January issue. The field winding of the small machine, which I assume is shunt-wound, is connected in parallel with that of the 5-h.p. motor. The armature is connected in parallel with the large armature, but outside the speed regulator, *R*, so as to be independent of the latter. The one starting box controls both motors simultaneously.

EDGAR S. BECK.

Treichlers, Pa.

The accompanying diagram (Fig. 1) shows probably the best solution of the problem in motor connections by Mr. Geo. W. Malcolm. The terminals of the small motor are connected to the corresponding terminals of the large motor, the speed-regulating rheostat being considered included in the system of the large machine. The starting box will then start both motors together while the speed rheostat will affect only the 5-h.p. machine.

H. A. CLARK.

Chicago, Ill.

The accompanying sketch (Fig. 1) is submitted as a solution to the problem in

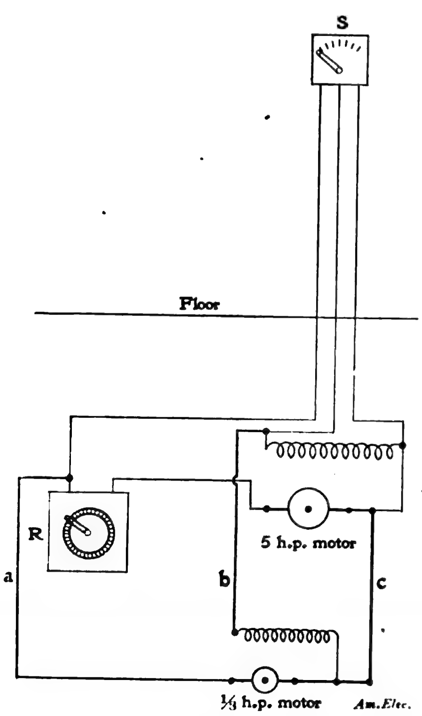


FIG. I.—SOLUTION OF MR. MALCOLM'S PROBLEM.

motor connections published last month in the AMERICAN ELECTRICIAN, and is practically self-explanatory. Instead of connecting the armature of the small motor in series with the resistance in the starting box, it could be connected direct to its field on the left-hand side, and the wire running to the rheostat, *R*, could be dispensed with, because I hardly think it would be

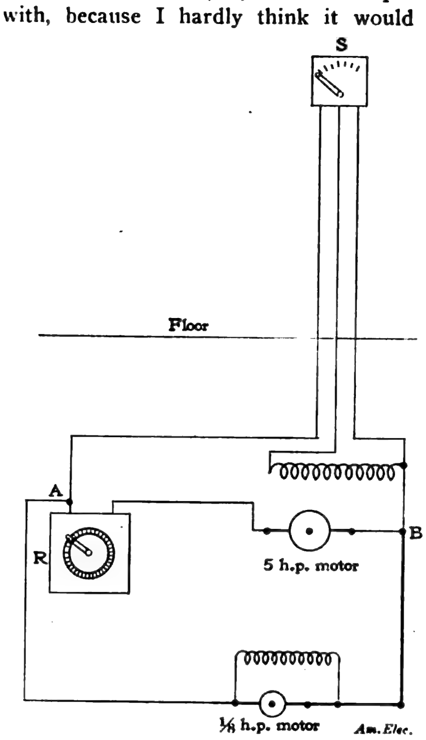


FIG. 2.—SOLUTION OF MR. MALCOLM'S PROBLEM.

necessary to use a starting box on so small a motor.

J. D. CONVERSE.

Chicago, Ill.

I enclose a diagram of connections (Fig. 1) which seems to fit the case described in Mr. Malcolm's letter last month. The diagram is self-explanatory. I have assumed that the small motor is shunt-wound, like the large one; if it is not, the wire, *c*, should be omitted and the wire, *b*, carried to the right-hand brush of the large motor instead of to its field winding terminal.

JAMES B. DILLON.

Louisville, Ky.

[Mr. Dillon's diagram was identical with Fig. 1, except that fuses were included in the leads, *a*, *b*, *c*.—EDITOR.]

Enclosed are two diagrams of connections (Figs. 1 and 2) submitted as solutions of Mr. Malcolm's problem, which appeared last month. Fig. 2 is possibly the simpler arrangement. The sketch is self-explanatory. In Fig. 1 the shunt field current of the $\frac{1}{8}$-h.p. fan motor adds its quota of current to the electromagnet on the starter, *S*, and may be objectionable on account of the heating effect on the electromagnet due to this extra current.

G. E. FREASE.

Youngstown, O.

Please find enclosed a solution (Fig. 2) of Mr. Malcolm's problem in motor connections published last month. The shunt field winding of the small motor is connected permanently to its brushes, and the complete motor is controlled by the starting box upstairs, but not by the speed-regulating rheostat, *R*.

J. H. GAUSE.

Wilmington, Del.

The accompanying diagram (Fig. 2) is submitted as a solution of Mr. Malcolm's problem in motor connections published in this department last month. It is based on the assumption that the starting box is of the no-voltage release type; also that the regulating box has no "dead" or off point. After the motors are started the voltage across points marked *A* and *B*, would remain constant regardless of the position of the contact finger on the regulating box, hence the $\frac{1}{8}$-h.p. motor would run at constant speed.

In consideration of the fact that a small motor will pick up speed much faster than a large motor, it would not be necessary to run a separate wire to the shunt field winding of the $\frac{1}{8}$-h.p. motor.

WM. MERRILL.

Wilmington, Del.

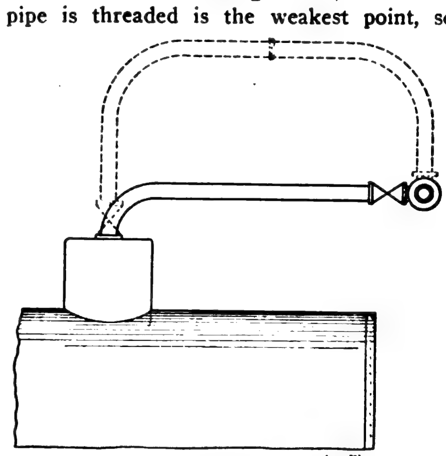
Enclosed find my solution (Fig. 1) to Mr. Malcolm's problem in the January number. The way I understand this problem is that Mr. Malcolm intends using one starting box for both motors. Practically this makes one piece of apparatus out of the two units, and for that reason I have omitted individual switches and fuses.

CHAS. B. SMEETH.

Ironwood, Mich.

Boiler Connections.

In reply to Mr. Walthall's question about boiler connections last month, the arrangement shown in the first case by solid lines would be best. Of course, it does not allow for expansion, but the pipe would be less liable to be broken than that shown by dotted lines. In the first case, the thread where the pipe enters the dome is subjected to a shearing strain, and would stand better than in the second case where the threads have to stand a bending strain; where the pipe is threaded is the weakest point, so



BOILER CONNECTIONS.

that the pipe would break, the break occurring on the sides facing each other. As to placing the valve as shown by dotted lines, if this boiler were shut down while other boilers in the battery were supplying steam, there would be condensation losses in this length of cold pipe. On the other hand, in the first case, it would be necessary to shut the boiler down to do any work on its delivery pipe.

HERBERT B. BRAND.

Brooklyn, N. Y.

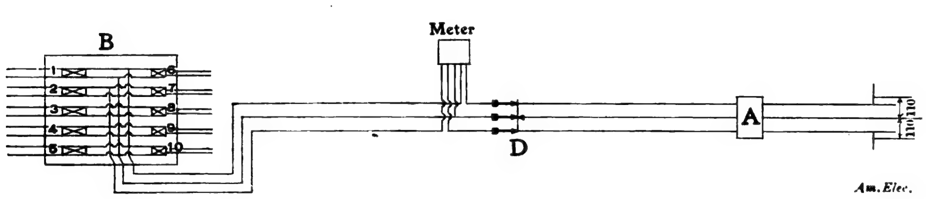
Referring to Mr. Walthall's boiler connections, I would much prefer the long bend shown by the dotted lines, but would put a reverse bend in between the end of the long bend and the boiler dome, and another between the other end of the long bend and the main header. This would make the intake and discharge of the boiler connection horizontal instead of vertical. The advantages would be that the steam flow would be better and the long bend would be less liable to break off in the threads on account of expansion and contraction. If one valve is to be used, it should be next to the main header, to keep steam from other boilers out of the long bend when this particular boiler is shut down. Two valves would be much better practice—one at each end of the long bend.

Los Angeles, Cal. SAMUEL TROTMAN.

An Insulation Resistance Problem.

I enclose a sketch of the main and branch circuit wiring in a building in this city, in testing which for insulation resistance I find a peculiar condition. The service is three-wire, 110—220-volt with the neutral conductor grounded at street entrance. The branch circuits are all two-wire 110-volt. All wires are installed throughout in iron conduits, which are securely grounded.

In connecting a voltmeter across the main cut-out, *A*, with one terminal to the + side of service and other connected to the entire system, all branch switches closed, I get a deflection of 20 volts. I also get the same reading between the negative side of the service and the system. With the voltmeter connected the same way, and all the branch switches at *B* open, the voltmeter shows 1 volt. When I close the main switch, *D*, and test each branch circuit separately at *B*, six show one volt ground and two show no leakage. The section between *A* and *D* tests free from ground leakage.



INSULATION RESISTANCE PROBLEM.

I should like to ask readers of this journal where the trouble might be located. I have worked on this matter for some time, and have reached no definite conclusion.

Baltimore, Md. ANDREW WESTERVELT.

Mr. Fulton's Dynamo Trouble.

Referring to the "Odd dynamo trouble" described last month by Mr. Fulton, I would say that about two years ago I had a very similar experience with a 10-kw. multipolar direct-current machine. Every conceivable test was made with instruments, and no fault could be located, yet the machine would refuse to generate, and no amount of short-circuiting appeared to affect it. I finally located the trouble, which was a combination of excessive resistance in the carbon brushes and imperfect contact in the brush-holders, which prevented the armature from energizing the shunt field. To remedy the trouble, I substituted brushes of lower resistance, and put a flat spring in each brush holder box. It seems to me Mr. Fulton's mysterious trouble may be accounted for along these lines.

Brantford, Ont. ARTHUR C. LYONS.

In regard to Mr. Fulton's odd dynamo trouble published last month, I would say that when he crossed the two brushes with his screwdriver the short-circuit caused the magnetism of the armature to help the field to pick up. I have used the same method quite often when a machine refused to pick up its field; that is, held a bare copper wire across the brushes. Mr. Fulton would have obtained as good results by disconnecting the shunt field and short-circuiting the machine with only the series coils and armature in circuit. But in doing this, it is well to use a fuse in the circuit to prevent damage. However, it would only make matters worse to short-circuit the terminals with the shunt field in circuit.

Floriston, Cal. F. V. MCAVOY.

I beg to offer the following explanation of Mr. Albert G. Fulton's dynamo trouble: The fact of the machine being compound-wound and not "picking up" when line was short-circuited would indicate that the field magnet had for some reason become reversed, so that residual magnetism in the pole-pieces would tend to send current through the field winding in the wrong direction. The accidental short-circuiting of the brushes by the screwdriver made a circuit of very low resistance independent of the field winding, and caused a very heavy current to flow through the armature, thereby magnetizing the field magnet by induction and causing the machine to immediately pick up the load.

Wilmington, Del. WM. MERRILL.

I read with interest Mr. Fulton's letter last month in regard to his dynamo trouble. It seems as though the only trouble with the dynamo was extremely weak residual magnetism in the field magnets, or else an excess of oil or other lubricant on the commutator. This last cause would be sufficient to keep a low-tension generator from building up on account of the high resistance between the brushes and the commutator. It seems to me as though the dynamo had already begun to generate when short circuited by the screwdriver. It would be impossible for the dynamo to generate if the brushes were short-circuited, because this would also short-circuit the shunt winding. If the leads were short-circuited on the line side of the compound winding then the dynamo might generate a very low e.m.f. by acting as a series dynamo. But, by short-circuiting the brushes, it would be impossible to make the dynamo generate, and for this reason I am inclined to think the machine had already started to "pick up" when short-circuited by the screwdriver.

Ironwood, Mich. CHARLES B. SMEETH.

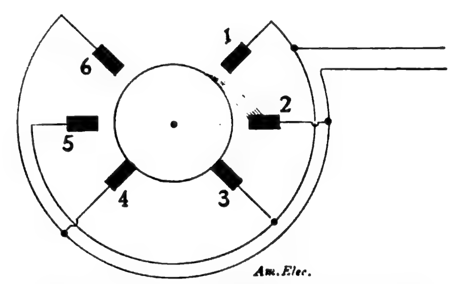
Mr. Anderson's Transformer Trouble.

Concerning the transformer trouble described last month by Mr. Anderson, I would say that when any load is thrown off an alternating-current line, self-induction causes a considerable momentary rise in voltage. This seems to be what happened when the load was taken off one of his transformers, and the rise of voltage caused excessive current to flow in the under-loaded transformer; the greater choking effect of the fully loaded transformer prevented the flow of excessive current in its windings.

Chicago, Ill. H. A. CLARK.

Arcing-over at Commutator Brushes.

During a test of a 6-pole 250-h.p. 500-volt motor, taking a potential curve around the commutator between successive pairs of brushes, a flash-over occurred without any apparent reason. The test was made with the field constantly excited and all brushes lifted from the commutator except the pair between which the test was being made;



ARCING-OVER AT COMMUTATOR BRUSHES.

after taking the curve between one pair of brushes, we put the next group down on the commutator and raised the group of the same polarity that had just been in test. When groups 2 and 3 had been tested (see diagram), group 4 was put down on the commutator and group 2 lifted; as this was done, the machine arced over from group 2 to group 1, which was raised from the commutator. The arc seemed to start between group 2 and the nearest commutator bar, and to spread gradually (relatively so) until it reached No. 1 group of brushes when the circuit-breaker went out. I should judge that the arc took about one second to reach the upper brushes after it had started between No. 2 and the commutator. The change from groups 1 and 2 to groups 2 and 3 was made without any trouble whatever. The armature was of the wave-wound two-path type. I should like to have readers of the AMERICAN ELECTRICIAN suggest what was probably the cause of the trouble.

Schenectady, N. Y. ROBERT E. NOYES.

Questions and Answers

Inquiries not accompanied by the name and address of the inquirer, will not receive attention.

The table of breakdown tests of mica plate published on page 31 of the last number of this journal shows that less voltage was required to pierce the thin plates than to pierce the thicker ones; why was this? D. L. G.

The voltages are the volts per centimetre of mica thickness, not the total applied volts

Why are form-wound and separately-insulated armature coils better than winding directly on the core, if the core is properly insulated? D. N.

Because the coils are of equal weight and resistance, and also because they are better insulated from each other than is possible in a core-wound armature. The ventilation is also better.

Why do the negative brushes on a rotary converter become overheated sooner than the positive brushes, with an overload? (2) What is the voltage between collector rings on the three-phase rotaries in the Manhattan sub-stations? M. I. H.

There is no general reason why they should; the cause must be some abnormal condition, which can be ascertained only by test and inspection. (2) 365 volts.

A small single-phase repulsion motor, running with a light load, becomes excessively hot in the armature; what is probably the cause? (2) Would subdividing the turns in the armature coils be advantageous? C. C. R.

The quality of iron in the armature core is poor, or else the discs are burred so as to give a good path for eddy currents parallel to the shaft. (2) Not as to the heating; it would otherwise.

I am running a 12-in. x 18-in. automatic medium-speed engine the valve of which has 3/8-inch lead when the crank is on the center; would not 1/32 or 1/16-inch be more economical? O. W. C.

It might be, but if the lead is the same on both ends it is correct for that particular design of engine, and it is better not to meddle with it. If it is widely different at the other port, adjust the valve-rod to equalize the lead.

Can pipes installed for hot water heating be used for supplying steam radiators? (2) What pressure is required for steam heating? E. W. D. C.

Yes, though they will usually be somewhat larger than necessary, and therefore entail a little more condensation. (2) From 5 to 10 pounds per square inch, according to the character of the service, and the weather conditions.

Can the hypothenuse of a right-angle triangle be determined if only the vertical side and the difference between the base and the hypothenuse are known? K. McL.

Yes: representing the hypothenuse by h, the vertical by v, the base by b and the difference between base and hypothenuse by d, the following relations hold good:

$$\frac{d^2 + v^2}{2d} = h; \quad \text{and} \quad \frac{v^2 - d^2}{2d} = b.$$

Does an incandescent lamp take more current when old than when new? (2) Can a recording watt-hour meter of the type used on three-wire direct-current circuits be used to measure the total power in a three-wire three-phase circuit? E. L.F.

No; it takes more current per candle-power, but the candle-power is much lower than when new. The actual current is less than when new, because the filament wastes away in service and increases its resistance. (2) No.

Will two brine pumps work satisfactorily discharging into a common manifold? (2) What is the relation between current and electrical horse-power in a 2500-volt circuit; what is it in a 125-volt circuit? W. D. W.

Yes; provided the pumps are adjusted to develop substantially equal pressures at their discharge outlets. (2) If the circuits are non-inductive, the electrical horse-power is equal to 3.35 times the current in the 2500-volt circuit and 0.1675 $\times$ the current in the other circuit.

What quantity of resistance wire should be used in series with a theatrical arc lamp supplied from a 110-volt circuit? J. G.

It depends on the current and voltage required by the lamp. Subtract the lamp voltage from the circuit voltage and divide the result by the current the lamp must pass; this gives the total resistance to be put in series. Divide the resistance by 0.005, and the result will be the number of feet of No. 10 galvanized steel wire required; or divide by 0.0074 to find the number of feet of No. 12 steel wire, or by 0.013 to find the number of feet of No. 14 wire.

Why are steadying resistances necessary in series arc lamps? (2) Are they required on series circuits as well as constant-potential circuits? H. J. Y.

Because the resistance of carbon becomes lower when it is heated, and the hotter the arc, the more current will flow at a given voltage, thus increasing the temperature of the arc, and further increasing the current, and so on. The resistance of the steadying coil *increases* with increased temperature, and compensates the tendency of the carbon to draw increased current. (2) Yes; on account of the decrease in voltage at each arc as the carbon becomes heated, the current being maintained constant.

If injectors heat and deliver water to boilers at higher efficiency than pumps and feed-water heaters, why are they not used to the exclusion of the other apparatus? (2) Why are direct-acting steam pumps, taking 100 to 150 lbs. of steam per horse-power per hour, used instead of more efficient pumping engines? W. T. K.

Other factors are involved in practical operation besides mere efficiency, and nearly all of the other factors are favorabde to the pump and heater. It is impracticable to discuss the subject adequately here. (2) Sometimes because the saving would not pay fixed charges on the extra cost of the more efficient pumps; sometimes because the purchaser of the pumps knows no better.

Will an alternator having one damaged field magnet coil cut out of circuit operate properly in parallel with other similar machines having no coils cut out? (2) If the bridged coil is in the armature, will parallel operation be feasible? (3) If one damaged field coil is cut out, should one of opposite polarity to it be cut out also to balance the field? B. H. E.

Yes; but its field strength should be made a trifle greater. (2) Yes; the field should be somewhat stronger to compensate for the reduced armature e.m.f. per unit of field strength. (3) Not necessarily; it might be advisable to cut out the coil diametrically opposite to the damaged and bridged one in order to equalize the radial magnetic pull on the armature core, but it would not probably be urgent to do so.

If railway feeders be re-inforced so as to reduce an excessive drop and thereby increase very greatly the potential at the cars, the bus-bar voltage being unchanged, will the power-house deliver more power to the lines than before on account of the increased speed of the cars? In other words, will the motors take more *current* at the higher speeds than at the lower, for a given controller position? C. J. S.

There would be a slight increase in current per car at any given controller position, and, consequently, a slight increase in the power actually delivered from the bus-bars, but the increase would be far less, proportionately, than the increase in car speed. Most of the increase in the power taken by the cars would be met by the increase in available voltage due to the decrease in line losses.

In some four-pole machines having two brush studs, the brushes rest on the commutator in direct line with the centers of the magnet poles; in others, the brush contacts are in line with the centers of the spaces between neighboring poles; which is correct? H. M. B.

Either arrangement is correct; the arrangement used depends on the way in which the armature leads are carried to the commutator; if one lead of each coil is carried straight out from the slot to the commutator bar in line with that slot, the brushes will be opposite the spaces between poles, but if both coil leads are bent sidewise away from the slots from which they issue and are carried to commutator bars equal distances beyond the axis of the two slots, the brushes will be opposite the pole centers.

What is the difference between long-shunt and short-shunt connections of compound-wound dynamos? (2) What is the difference between the results obtained? (3) What are the relative advantages of waves and lap-wound armatures? C. P.

The shunt-field circuit is connected to the extreme terminals of the machine for "long shunt" and to the brush terminals for "short shunt." (2) There is no important difference practically; with the long-shunt connection the rise of voltage at the shunt-field terminals from no load to full load is a trifle less with the short-shunt connection, which would be advantageous if the difference amounted to anything. Long-shunt connection is preferable to short-shunt, however, where two or more machines are operated at the same voltage because the field of any machine can be excited from the bus-bars when the machine is started up, and its polarity thereby made certain. (3) In a wave winding, each path through the winding passes under every magnet pole, so that the e.m.f. induced in each is the same as that in the others, no matter how irregular the field strengths may be; in a lap winding, each path passes under only two poles, and unequal field strengths induce different e.m.fs. in different paths, making equalizer connections necessary to prevent local currents from flowing in the weaker paths. On the other hand, commutation is more difficult in a wave winding because two or more coils in series are short-circuited at the brushes, and the inductive "kick" is multiplied two or more times.

POWER-HOUSE COAL-HANDLING MACHINERY.

A very interesting and modern equipment of coal-handling machinery is that recently installed in the new power-house of the Philadelphia Electric Company, located

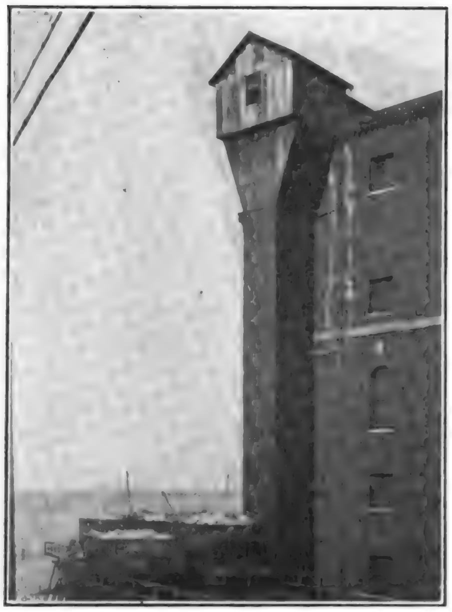


FIG. 1.—STEEL TOWER CONTAINING PATENTED GRAVITY DISCHARGE ELEVATOR AND CONVEYOR.

at Christian Street Wharf, Schuylkill River, Philadelphia, by the Link-Belt Engineering Company, of Philadelphia.

The boiler house, which is a double decked one, stands on low ground adjacent to the Pennsylvania Railroad tracks, and has sufficient floor space to accommodate 16 650-h.p. boilers on each floor. At the present time twelve boilers have been installed on the first floor, nine of which are in use and consume on an average 100 tons of bituminous coal per day of 24 hours.

Coal cars are shifted into the yard on a double track trestle, elevated 27 ft. above the basement of boiler house, at which point they drop their contents into a steel hopper spanning both tracks. This hopper is fitted with a reciprocating feeder, which, it is claimed, controls the delivery of lump anthracite or bituminous with masses 30 ins. and larger in diameter, as readily as it does the delivery of buckwheat coal. This is rendered possible by the fact that the rate of delivery is entirely independent of the size of the discharge opening in the hopper, and that the opening can, therefore, be made large enough to suit the lumps to be handled.

By means of the reciprocating feeder, coal is automatically transferred in uniform quantities and regularly, to an inserted steel tooth crusher, and besides dispensing with the labor of one man at the hopper, to assist and regulate the flow of coal, it prevents overloading the machine and consequent dangers.

The crusher is mounted on a cast iron frame and enclosed by a steel housing. It is made with two charcoal iron, chilled rolls, one of which is mounted in spring bearings, to allow it to yield to a piece of iron or other hard article that may enter the machine. The crusher and feeder are driven by a 15-h.p. motor.

From the crusher coal is spouted to the lower horizontal run of a patent gravity discharge elevator and conveyor, consisting of two strands of forged chain with steel buckets attached at intervals. The vertical run of the machine is supported on foundations by a steel tower sheathed with corrugated iron. (Fig. 1.)

After receiving coal from the crusher, the gravity discharge elevator and conveyor conveys it 30 feet horizontally, then 106 feet vertically, and then 60 feet horizontally directly under the roof of boiler house. A 30-h.p. motor is used for operating this machine.

On the upper horizontal run, coal is discharged into either one of two roller flight conveyors, designed to permit an increase in length when the boiler house is extended. Each of these machines is driven by a 15-h.p. motor, and consists of suspended roller flights attached at intervals to closed joint link-belting. (Fig. 2.) On the conveying run the rollers serve to suspend the flights, so that they will not come in contact with the trough, thus preventing noise and reducing wear to the minimum. The coal is distributed in the 2,000 ton pocket through rack and pinion discharge gates with which the conveyor troughs are fitted.

The coal bunker is equipped with eight chutes, which are arranged to spout the coal in front of the boilers on first and second floors. While this machinery is guaranteed to handle 100 tons per hour, the crusher, it is claimed, easily reduces run-of-mine bituminous coal to about 3 in. cubes, or smaller, at the rate of 130 tons per hour, the elevator and conveyor having capacity to handle the crushed coal at the same rate.

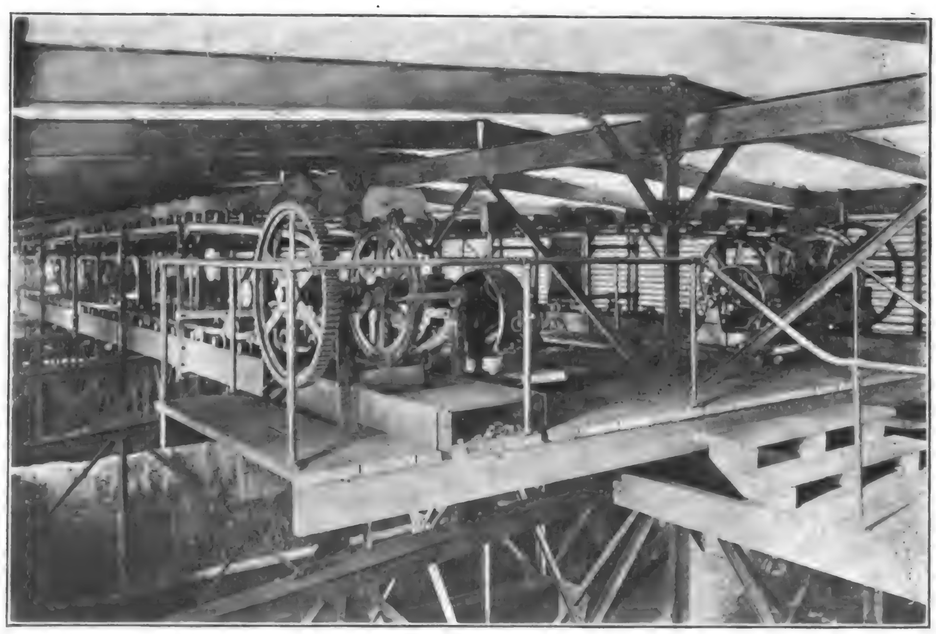


FIG. 2.—DRIVING ENDS OF TWO ROLLER FLIGHT CONVEYORS.

Before the installation of the elevating and conveying machinery, coal was unloaded by a crane equipped with clam-shell bucket, in a pile about 200 yards from the boiler house, and then reloaded by the same crane into trolley cars and carried to the boiler house. This operation required the services of six men every day, whereas the present equipment is said to necessitate the employment of but one man one hour each day to keep the bunker well supplied with coal, and has the further advantage of always having in reserve enough coal to meet all demands of the boilers for twenty days.

THE BOX ELECTRIC ROCK DRILL.

Fig. 1 herewith shows a Box electric rock drill made by the Denver Engineering Works of Denver, Colo., in which many im-

FIG. 1.—BOX ELECTRIC ROCK DRILL.

provements are said to be embodied. Cross-sectional views are given in Fig. 2. The motor designated to be waterproof is shown to the left, mounted on the guides of the shell and coupled to the drill proper by means of machine-cut forged-steel gears. A taper-pin with nut, fastens the motor to the drill and the removal of this pin permits the motor to be removed. It will be noted that the element corresponding to the cross-head of an engine becomes a cylinder in which is fitted the hammer of the drill. This cylinder of cast iron is machine fin-

ished inside and out, and the forged steel hammer is also machine finished all over and fitted to the bore of the cylinder. The form of hammer resembles the piston and rod of a steam engine, leaving an air space between the piston of the hammer and the heads of the cylindrical cross-head. When the drill is in motion the air on each side of the hammer-piston is alternately compressed and rarefied, giving exactly the effect of a spring between the cross-head and hammer. To compensate for possible leakage and to insure a full supply of air, two ports are cut in the side of the moving cylinder, which are so located that as soon as the piston moves from its central position one port is opened to the atmosphere and a supply of air rushes in; then the other port opens and furnishes an air supply to the other side of the piston. Thus, these two ports serve to equalize the air pressure on both sides of the piston as it passes its central position. Oil-grooves are turned in both piston and rod to furnish an oil-packing between the piston and the cylinder walls; also between the rod of the hammer and the cylinder head. Fig. 1 is of a drill with the cover removed in order to show the internal mechanical construction.. The electric current is conducted from the main transmission wires to the controller through heavy rubber-covered mains. The controller is of special design, and includes the necessary resistance for five speeds with proper fuse blocks, all contained in a compact aluminum waterproof case. Connection is made with the drill motor by a short heavy rubber-insulated cable. The motor was designed by the General Electric Company expressly for drill work, and while every means are employed to reduce the size and weight, all precautions are taken for careful insulation and substantial construction. The motor has a waterproof case and aluminum caps are used on the pinion and commutator ends. Suitable hand-holes are provided for inspection and care of the carbon brushes. The motors are wound for 110 or 220 volts, direct current. It would be useless to enumerate the advantages of the electric over other forms of drill. As compared to the air or steam drill the relative advantage in the amount of power consumed is said to be in the ratio of 1.5 to 14.

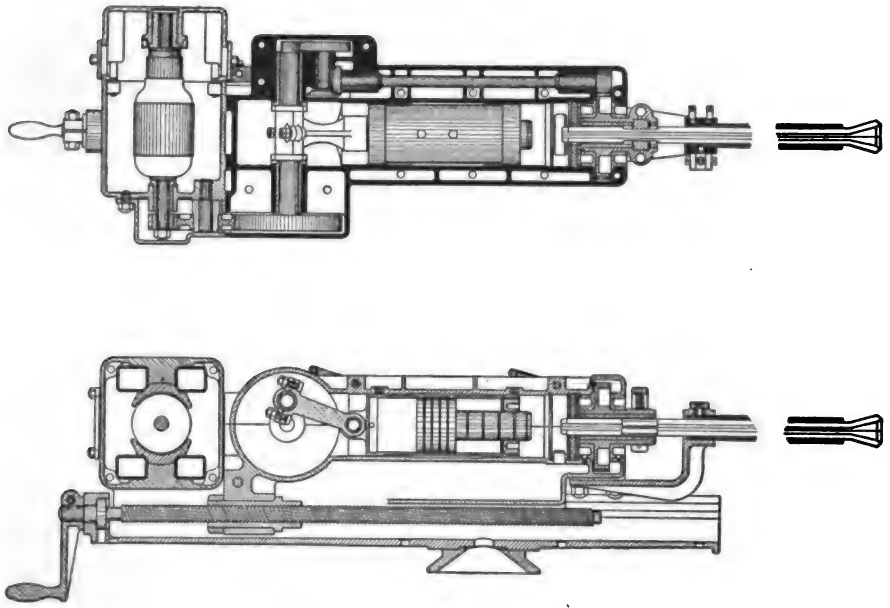


FIG. 2.—SECTIONAL VIEWS OF BOX ROCK DRILL.

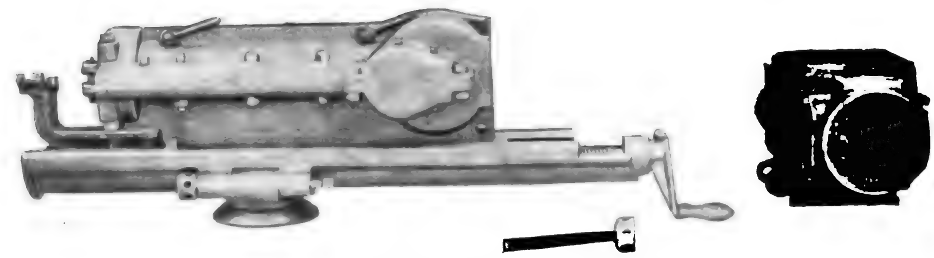


FIG. 4.—BOX DRILL WITH MOTOR REMOVED.

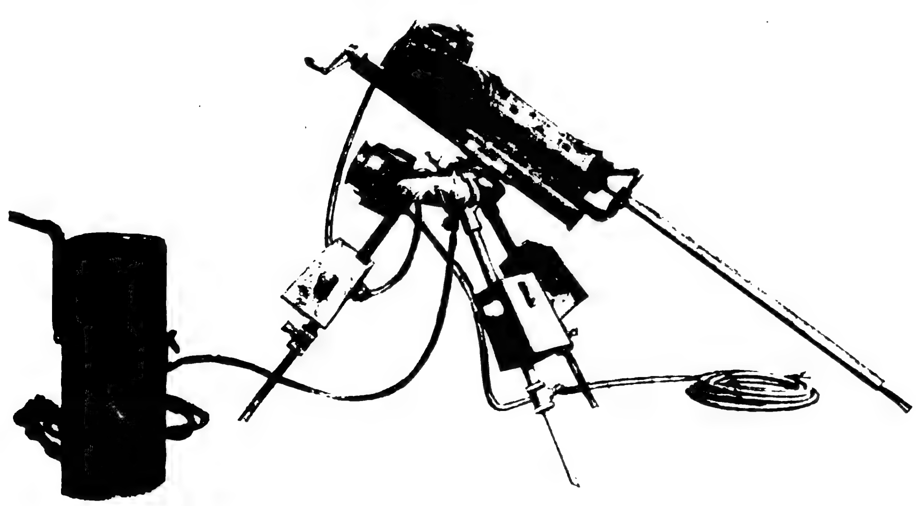


FIG. 3.—BOX ELECTRIC ROCK DRILL.

METHOD OF HEATING AND REGULATING BOILER FEED-WATER.

Among the new problems and opportunities presented by the recent commercial development of the steam turbine is the application of the auxiliary equipment in plants operated by turbines. The Harrison Safety Boiler Works, of Philadelphia, Pa., have paid special attention to the adaptation of their Cochrane heaters to such plants, and have developed some features in these installations which should prove of interest to engineers. The accompanying illustration, Fig. 1, shows an approved method, covered by letters patent, for heating and regulating the boiler feed-water, and is particularly adapted to plants where the steam turbines are operated in connection with surface condensers, although it is also applicable to plants where surface condensers are used in connection with reciprocating engines. 1 is the main steam turbine taking steam through the pipe, *1a*, from the boiler. 2 is the exhaust pipe from the turbine to condenser. 3 is the surface condenser receiving the exhaust from 2. 4 is a pump taking cold water through suction pipe, *4a*, and forcing it through pipe, *4b*, into the condenser. *4c* is the discharge for the circulating water. 5 is an auxiliary engine driving a pump, 6, for drawing the condensation from the condenser and delivering it to the open heater through the pipe, *6a*. *5a* is the exhaust pipe from this auxiliary engine joining the exhaust, *5b* from 4. 7 is a feed-water heater receiving the exhaust from the auxiliaries through the oil separator, 8. 9 is a pump taking the feed-water from the heater through the pipe, 10, and discharging it to the boilers through the pipe, 11. The exhaust from this pump, joining the other auxiliary exhaust, enters the separator, 8. 12 is the supplementary cold-water feed supply emptying into the condenser, 3, to make up any difference between the quantity of condensation and the amount of water required by the boilers. The supplementary water is controlled by the valve, 13, according to the level of the water in the heater, 7. This valve is automatically closed or opened by the float and connecting mechanism. 14 is an air pump exhausting air from the condenser, 3, through the pipe, 15. In cases

where this pump is steam-driven, the exhaust also enters the separator, 8. 16 is the exhaust from the heater to the atmosphere and is provided with a back pressure valve, 17. 18 is an air pipe leading into the condenser and provided with the air valve, 19, for passing to the condenser the air which is liberated from the water by heating it in the heater. By this means the air in the heater is disposed of without permitting the escape of steam. Should there be more exhaust from the auxiliaries than can be condensed in the heater, the pressure increases until it is high enough to open the back pressure valve, 17, and allows the surplus to escape to the atmosphere. It often occurs, however, that the steam from the auxiliaries is insufficient to heat the feed-water to the desired temperature. In order to cover such cases the pipe, 20, is carried to the heater from such a point of expansion in the turbine as will insure the least loss of effectiveness with the greatest potentially for the purpose of making up any possible deficiency in the auxiliary exhaust. In the pipe, 20, is placed an automatic throttling valve, 21, so adjusted that the pressure of the steam when it enters the heater shall be below the pressure at which the back pressure valve, 17, is set. Thus the supply of supplemental steam from the turbine depends upon the pressure in the heater, and is regulated by the needs of the heater itself. The operation of this novel arrangement has important advantages. In addition to all of the condensation of the main exhaust being utilized in the heater, the supplementary cold water is automatically regulated and supplied, and is partially heated in the condenser by the utilization of the latent heat in the main exhaust. All of the exhaust from the auxiliaries is said to be utilized up to the point where they provide more exhaust than is required in the heater, and should the supply fall below the maximum quantity required it is automatically supplemented by steam in the manner already described. The boilers are furnished with water at a uniformly high temperature, there being no sudden fall in the temperature due to variations in the quantity of steam available for heating the water or in the quantity of the supplemental cold water required. The methods by which these desirable results are obtained are claimed to be simple, positive and entirely automatic. It will be seen that in a plant in which this method of heating and regulating the boiler-feed supply is used the auxiliaries are of the independent, steam-driven, non-condensing type. The manner in which the exhaust from these auxiliaries is utilized, however, makes them, it is said, far more economical than the turbine or main engine run condensing, even though the latter may show an efficiency of 15 per cent. or better. If the auxiliaries were run condensing, they could not exceed and probably would not equal this efficiency of 15 per cent., but when operated in the manner described above, their efficiency is very high, for all of the heat in the steam which is not converted into work or accounted for by losses from radiation, etc., is claimed to be utilized in heating the feed-water and turned back into the boilers.

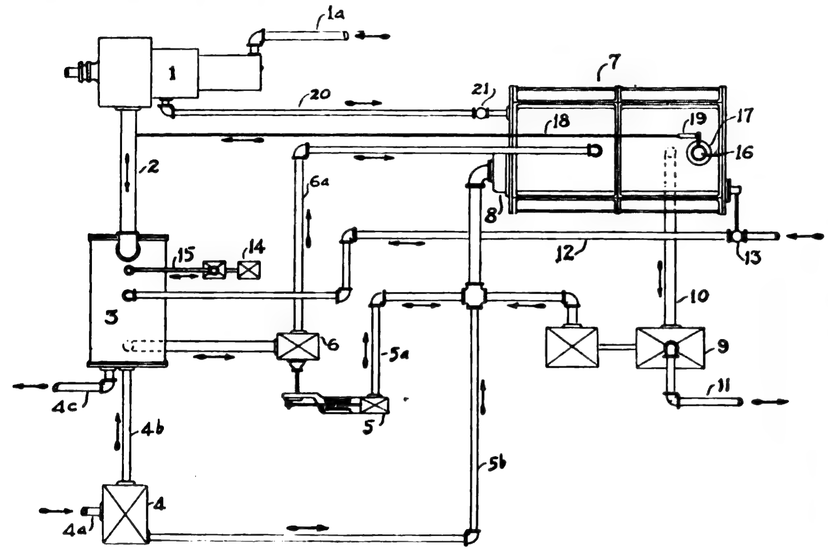


FIG. 1.—SYSTEM OF HEATING AND REGULATING BOILER FEED WATER.

NATIONAL ELECTRICAL CODE STANDARD FUSES.

One of the most important and radical steps in the realm of electrical fittings will be completed April 1, 1905. A universal line of fuses and bases has been adopted by the National Board of Fire Underwriters, and will be the only one approved by that board and allied societies on new work after the above date. All fuses and bases of any given capacity sold by the manufacturers of approved fuses must be interchangeable.

In September, 1903, a joint conference of the Underwriters' Committee, and the leading manufacturers of fuses took up the initial work of securing a national standard fuse, and mapped out a complete line for voltages up to 600, and carrying capacities up to and including 600 amperes. This line was intended to fill all standard requirements within the above limits. Between that time and the present, a great amount of time and money has been expended to determine the exact dimensions and to test fuses made according to the proposed sizes.


FIG. 3.

The first feature to be considered is the style of contacts adopted. They are as follows: (1) Edison or screw plug; (a) 125 volts, (b) 250 volts. (2) Ferrule contact. (3) Knife blade terminal.

The first class includes, under "A," the well-known form of porcelain shell with the brass cover containing a piece of fuse wire soldered to the two terminals. (Fig. 1.)

This fuse is approved on circuits not exceeding 125 volts, in capacities up to and including 30 amperes. For voltages above 125, and not exceeding 250, there is a screw plug type known familiarly to the trade as a "Re-fill." This comprises a porcelain shell containing an enclosed cartridge fuse which may be renewed by a fresh cartridge when the latter is blown. (Fig. 2.)

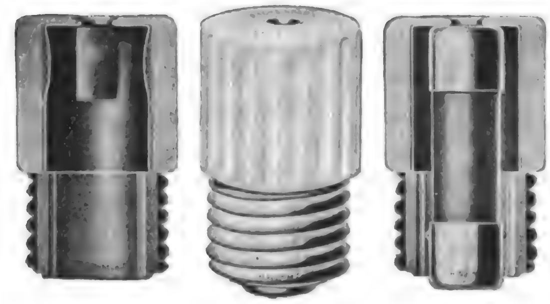


FIG. 2.—NATIONAL STANDARD FUSE PLUG.

Class two, or the ferrule contact cartridge, may be used either in the renewable plug or in spring clips, so formed as to engage a considerable part of the external circumference of the ferrule, and is of the same construction for either place. Fig. 3 shows a standard slate base equipped with spring clips.

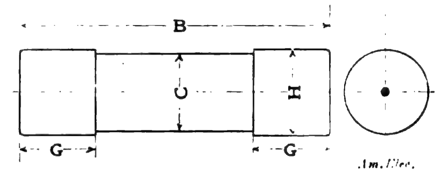


FIG. 5.—0 TO 60-AMPERE CARTRIDGE FUSE.

For all the higher capacities a switch type of contact with a fuse as a knife inserted in one or another form of switch contacts is required. Fig. 4 shows a 400-ampere base and fuse of this type.

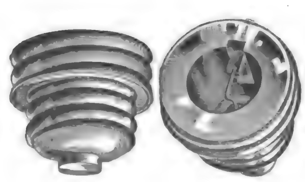


FIG. 1.

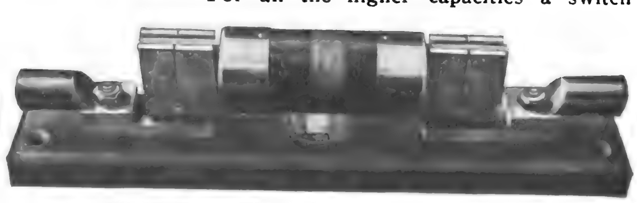


FIG. 4.—400-AMPERE BASE AND FUSE.

The following is a classification with re-

gard to voltage and carrying capacity of the complete line of fuses as described:

0—125 VOLTS.

0—30 amperes, Edison screw plug.

125—250 VOLTS.

3—30 amperes, (Edison screw casing) cartridge fuse, ferrule contact.
31—60 amperes, (spring clips) cartridge fuse, ferrule contact.
61—600 amperes, cartridge fuse, knife blade contact.

251—600 VOLTS.

3—30 amperes, (cartridge fuse) ferrule contact.
31—60 amperes, (spring clips) ferrule contact.
61—400 amperes, cartridge fuse, knife blade contact.

The object sought in a choice of contacts was to secure ease of manipulation in renewing fuses without the aid of tools, and at the same time have sufficient contact to prevent heating. Moreover, it is desired, as far as possible, to prevent improper renewing with any object at hand other than the proper fuse.

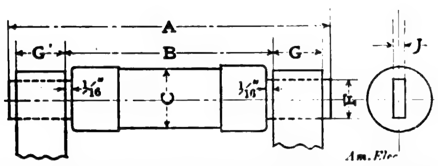


FIG. 6.—61 TO 600-AMPERE CARTRIDGE FUSE.

Next in impoPtance to the style of contacts used is that of detail of construction. The following is a tabulation of the dimensions common to all National Electrical Code standard fuses, the two voltage classifications being distinguished by colors of labels: 250 volts, green; 600 volts, red. The dimensions of the several classes of fuses in the two voltages are made such that no 250-volt fuse can be placed in a 600-base, or one of a given class placed in a base of lower capacity.

250 VOLTS.

Capacity amperes.	B.	C.	G.	H.
0—2				
3—30	2	1/2	1/2	9/16
31—60	3	3/4	3/4	13/16

600 VOLTS.

Capacity amperes.	B.	C.	G.	H.
0—2				
3—30	5	3/4	3/4	13/16
31—60	5 1/2	1	7/8	1 1/16

250 VOLTS.

Capacity amperes.	A.	B.	C.	F.	G.	J.
61—100	6	4	1	3/4	7/8	1/8
101—200	7 1/4	4 1/2	1 1/2	1 1/8	1 1/4	3/16
201—400	8 3/4	5	2	1 5/8	1 3/4	1/4
401—600	10 1/2	6	2 1/2	2	2 1/8	1/4

600 VOLTS.

Capacity amperes.	A.	B.	C.	F.	G.	J.
61—100	8	6	1 1/4	3/4	7/8	1/8
101—200	9 3/4	7	1 3/4	1 1/8	1 1/4	3/16
201—400	11 3/4	8	2 1/2	1 5/8	1 3/4	1/4

All of the knife blade contacts are designed for 70 amperes per square inch of surface contact, this having been found by numerous tests to give a rise of temperature that will not affect, detrimentally, the action of the fuse.

Specifications for enclosed fuses require that all fuses shall carry 10 per cent above their rating under room conditions of 70 to 75° Fahrenheit indefinitely, and that when running normally, shall blow at a current not exceeding 25 per cent above their rating without heating sufficiently to damage the exterior of the fuse. With a current 50 per cent greater than the rating, and at room temperature as before, fuses of the various classes, started cold, must blow within the following specified time:

0— 30 amperes,	30 seconds
31— 60 amperes,	1 minute
61—100 amperes,	2 minutes
101—200 amperes,	4 minutes
201—400 amperes,	8 minutes
401—600 amperes,	10 minutes

All enclosed fuses must be able to stand a short-circuit test, one at a time, when placed on a line having a capacity of at least 300 kilowatts at the voltage for which the fuse is rated, and must not hold an arc, or throw out melted metal or flame to ignite easily inflammable material on or near the fuse.

All the fuses are equipped with indicators which shows at a glance, when the fuse is blown. The ingenuity shown in these indicators is illustrated in the line of fuses manufactured by the Chase-Shawmut Co., of Newburyport, Mass., where a sudden rush of current through an auxiliary or shunt wire of German silver at the blowing of the fuse, heats the wire red hot and fires a powder cap placed adjacent to it, in a small pocket, and ejects a red disc placed in an opening of the tube.

A thoughtful consideration of the requirements of this new line of fuses brings one to the conclusion that a long step ahead has been taken from the old link fuses. The rapid progress in all departments of electrical industry finds no exception in the branch of fuse manufacture, brought to the public notice at this time by the adoption of the National Electrical Code standard fuses and fittings.

TRANSFORMER OUTFITS FOR THAWING PIPES.

The manifest superiority of electricity as a thermal agent in thawing frozen pipes, and the field for this service that awaits development has attracted a considerable amount of attention on the part of central station managers, many of whom have improvised outfits for this purpose. A very general demand for thawing outfits has arisen to meet which the Westinghouse Electric and Manufacturing Company has designed the transformer shown by Fig. 1.

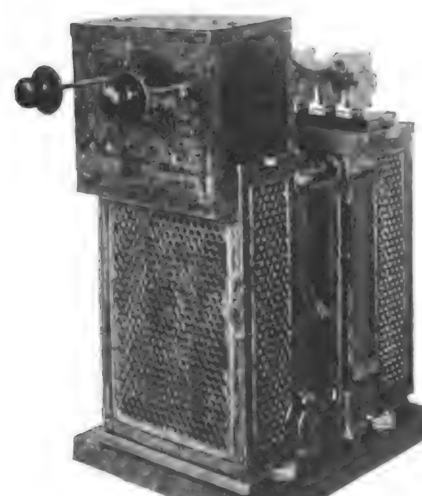


FIG. 1.—TRANSFORMER FOR THAWING PURPOSES.

The outfit weighs complete with transformer, switchboard and base, 750 pounds. It occupies a floor space 2 ft. 4 ins. by 1 ft. 10 ins., and is 1 ft. 7 ins. in height. A link in the top of the transformer case affords a means of lifting the outfit, and if desired truck wheels may be attached to the wooden base. The transformer may be operated satisfactorily on circuits varying from 1800 to 2500 volts. The low tension is arranged to deliver approximately 500 amperes for several hours at an e.m.f. from 15 to 50 volts. By a simple change in connections, the windings may be arranged to deliver about 1000 amperes at voltages from 8 to 16, for thawing large mains whose resistance is generally low. The outfit is suitable for thawing pipes from a ½ in. to a 1 ft. main. The transformer is generously designed, and will deliver large overloads for short periods of time. The windings are air-cooled. The insulation is not injured by rain, snow or ordinary abrasion. There are no moving parts to get out of order, and the entire outfit is contained in a single unit. A light but substantial switchboard is mounted upon the high tension end of the transformer. The switches are of the enclosed plug type, such as are used upon high tension arc light circuits, and permit a variation of the low tension voltage, and consequently the current supplied to the pipes. The company also makes a smaller outfit particularly adapted for thawing service piping about dwelling houses. It is light, of such proportions as to make it easy to handle, and is mounted in a wooden box provided with a handle and shoulder strap. It has a capacity of 200 amperes at potentials up to 25 volts for one hour. It is arranged for operation from a nominal 2000-volt circuit, but can be supplied for any other primary voltage even as low as 200 volts. The voltage regulation and current control are obtained through plug switches in the high-tension circuit. When desired, the outfits are furnished with a current-measuring device, so that the operator may know the amount of current that is being used.


FIG. 2.—TRANSFORMER FOR THAWING PURPOSES.

New Apparatus and Appliances

GENERAL ELECTRIC CEILING SNAP SWITCH.

Fig. 1 herewith shows a new single-pole ceiling snap switch brought out by the General Electric Company. The mechanism of the switch, which is very simple, is operated by pulling a chain attached to the switch, which causes a cam to engage a rachet which in turn operates the switch.

FIG. 1.—G. E. CEILING SNAP SWITCH.

The make and break are positive, the mechanism being similar to the General Electric Company's standard snap switch. The current-carrying parts of the switch are thoroughly insulated from the operating mechanism, and are of sufficient cross-section to prevent excessive heating. The switch is mounted on a porcelain base, and has a nickel-plated cover. It has a carrying capacity of 3 amperes at 220 volts, or 6 amperes at 110 volts.

MERRILL'S TWIN STRAINER.

Fig. 2 herewith shows a twin strainer brought out by G. U. Merrill, of Paterson, N. J., for catching refuse that may be in the water flowing in any pipe, such as the suction to feed or bilge pump or injection pipe to condensers, and permitting the removal of the refuse without interrupting the flow of water. The "Ideal" twin strainer, as it is called, has a cast-iron case, in which are two separate compartments, each containing a perforated sheet brass strainer of ample area for the size of pipe. One of these strainers is always shut off by means of the slide valve shown in the illustration, while the other strainer is performing its work. The valves are fitted with renewable Jenkins' discs. The construction is such that by a half turn of a set screw, the door can be taken off and the strainers removed for cleaning. In operation the device is connected in the suction line and the strainers placed in the case so that the refuse is caught inside the basket or strainer. When one becomes clogged, the valves are run to the other side by means of the hand-wheel, and this automatically closes the clogged strainer and opens the clean one. The cover can then be removed, and the strainer cleaned and replaced ready for use again. The flow of water is not interrupted during this operation, so that the usefulness of the device is apparent.

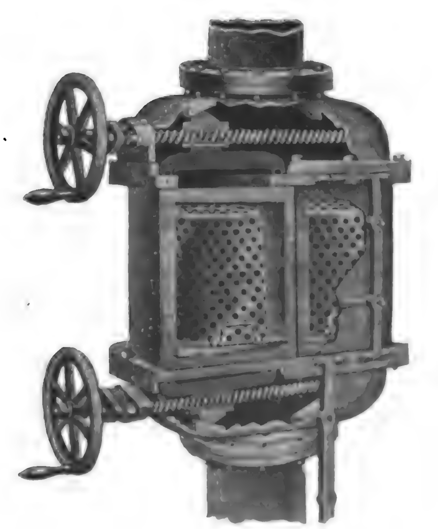


FIG. 2.—MERRILL'S TWIN STRAINER.

NEW EXPERIMENTAL DYNAMO.

Parsell & Weed, New York, have added to their line of small machines for experimental work and amateur construction an interesting little dynamo or motor of the circular yoke type. Figs. 3 and 5 inclusive illustrate the machine and its component parts. The frame is of cast iron, with the poles and yoke-ring cast in one piece; the armature is of the standard laminated and slotted-core type that is used in all commercial machines, drum-wound. The machine is furnished with any of the following windings: 6-volt dynamo for plating, gas engine ignition, etc.; 110-volt dynamo of 110 watts capacity at 1200 r.p.m.; 110-volt dynamo of 220 watts output at 2400 r.p.m.; 110-volt dynamo of 330 watts output at 3600 r.p.m.; dynamotor to reduce from 110 volts to any specified lower voltage, or vice versa. Of course, the machine can be used as a motor at any of the dynamo voltages by putting a starting-box in the armature circuit and taking out the rheostat in the field circuit. The builders sell the complete machine, or the unfinished parts, or the parts finished but unwound, as the purchaser desires. Blueprints and instructions for winding accompany the parts. Other combinations with the same frame will be brought out immediately, such as motor-generators, rectifiers, rotary converters, etc.

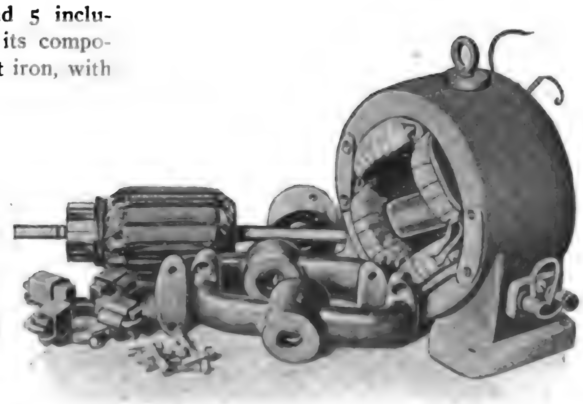


FIG. 3.—NEW EXPERIMENTAL DYNAMO.—Fig. 4.

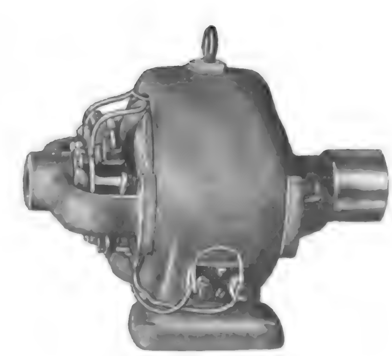


FIG. 5.—NEW EXPERIMENTAL DYNAMO.

ELECTRIC TIME SWITCH.

Fig. 6 shows a time switch marketed by the American Electric Sign Company, of Boston, Mass. The mechanism of this switch is entirely mechanical, the current traversing the switch only. In the upper left-hand corner is a clock movement having two dials, one above the other, the under one of which is calibrated so that every 15 degs. represents an hour. A pin on the front dial engages the front lever which releases the clutch allowing the switch axle to turn through an angle of 90 degs. and close the circuit. A similar arrangement on the back dial engages the back lever which releases a second clutch allowing the switch blades to rotate 90 degs. more and open the circuit. As both dials revolve at the same rate of time all that is necessary to set the switch is to place the pin on the front dial as many hours in advance of the pin on the back dial as one wishes to keep the circuit closed. The cylinder to the left of the switch contains a strong spring, which is wound with a key and which furnishes the power to rotate the switch axle.

FIG. 6.—ELECTRIC TIME SWITCH.

THE BOSWORTH COMMUTATOR FILING DEVICE.

As a means for truing generator commutators which shall be less expensive than turning them down with lathe tools, the Excelsior Machine Works, Akron, Ohio, has placed on the market the device illustrated

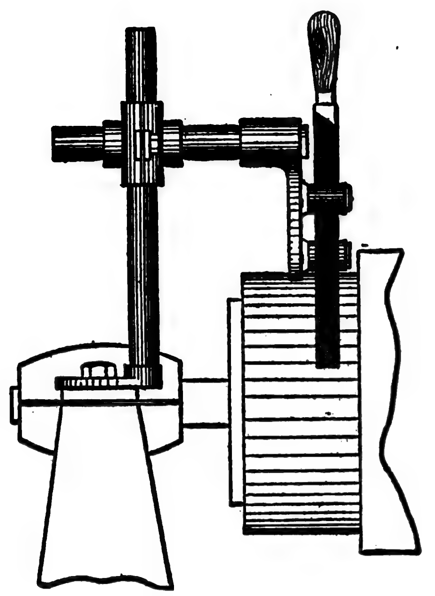


FIG. 7.—COMMUTATOR FILING DEVICE.

herewith. The simple construction and method of attaching it to a generator are shown in the illustration. One of the principal advantages is that no particular skill or previous experience in truing commutators is required to insure satisfactory results. The supporting column for the device is provided with a suitable foot for securely attaching it under one of the cap bolts on the generator bearing. This carries a horizontal bar, which may be

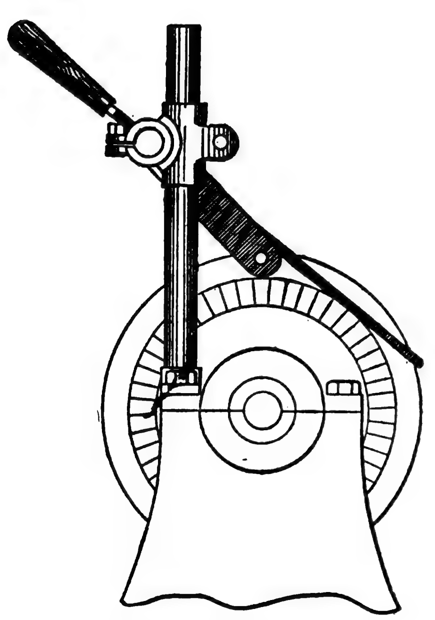


FIG. 8.—COMMUTATOR FILING DEVICE.

clamped at any desired height. The file-holder slides on the horizontal bar, so that the file may be passed across the surface of the commutator. An ordinary file is used, being held in proper position by pins or file rests in the file holder, one of which is slotted and located so as to steady the file and prevent chattering. The file is moved backward and forward over the commutator and, being rigidly secured, cuts to uniform depth, thus not only leveling the surface lengthwise, but restoring the true cylindrical form. As the device is so readily applied, the commutator may be smoothed off as soon as the surface shows the first signs of roughness or unevenness and before it has become sufficiently worn to warrant the removal of the armature or the turning of the commutator by means of a cutting tool. The perpendicular post can be left on the generator at all times if desired, and the horizontal bar can be taken off and put on in a few minutes. The device is applicable to all sizes of generators.

COMBINED BRACKET AND KNOB INSULATOR.

Figs. 9 and 11 show a combination bracket and knob insulator brought out by the Snyder-Hunt Company, of Belle Plaine, Iowa. The fastening screw is passed obliquely through the insulator, so that when once fastened the bracket is prevented

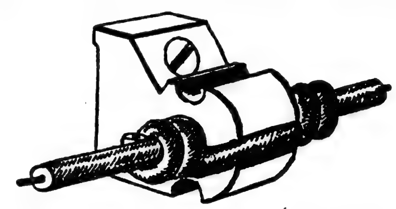


FIG. 9.—SNYDER-HUNT INSULATOR.

from turning. Shoulders on the inner face of the bracket are also provided to secure this result. The knob portion has a transverse bore through which the conductor wire is passed. Grooves are also provided on three sides for fastening wires. While it is intended that the conductor shall pass

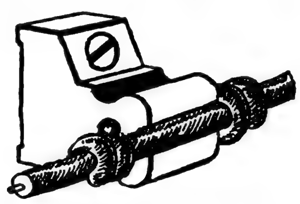


FIG. 10.—SNYDER-HUNT INSULATOR.

through the hole and the fastening wires rest in the grooves, this order may be reversed where it becomes necessary to connect a knob to a wire already in place. With the conductor passing through the insulator, tie wires are not absolutely essential, so that speedy and efficient wiring is

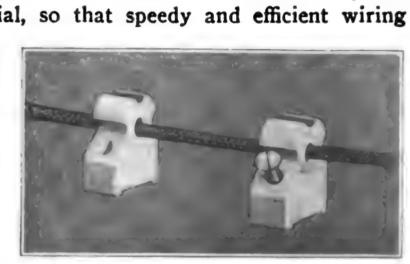


FIG. 11.—SNYDER-HUNT INSULATORS.

possible by the use of the device. Fig. 9 shows the conductor passing through the hole in the knob with the tie wire in the groove, while Fig. 10 shows the conductor in the groove with the tie wire passing through the hole.

TRUMBULL SERVICE BOX.

The Trumbull Electric Manufacturing Company, of Plainville, Conn., has brought out an iron service box for use in cellars or damp places, or where inflammable material is used. The box can, of course, be placed anywhere to enclose a switch and

FIG. 12.—TRUMBULL SERVICE BOX.

cutout so that its applicability is not limited to any particular location. The manufacturers claim that the box is both fire and moisture proof. It is provided with bushings for wire or drilled to take iron pipe conduit. When enclosed fused switches are used in these boxes, the switches are made special as shown. The sizes of boxes range from 8 ins. long and 3 ins. wide to 22 ins. long and 5 9/16 ins. wide. Five sizes of box are built; they are all finished in Venetian black.

TROY AMMETERS AND VOLTMETERS.

The Troy Electrical Company, of Troy, N. Y., are placing on the market a line of switchboard ammeters and voltmeters, one of which is shown by Fig. 13. The working elements consist of a permanent magnet and two stationary coils, together with a pointer and its pivot provided with a small steel vane. The vane is .01 in. thick and ¾ in. in diameter. The instrument is said to be dead beat, a small aluminum damper being provided. The resistance, 3000 ohms for a 125-volt meter, is formed of an alloy

FIG. 13.—TROY VOLTMETER.

having a small heat coefficient. The magnet is made of tungsten steel, the length of steel being over 14 ins. The air gap bridged by the steel vane of the moving element is said to be very short. The company claims that the instrument is very sen-

sitive and has an open scale throughout its length. The scale is said to be more open in those portions most read. The iron base and cover form a magnetic shield so that the instruments are not easily thrown out by stray magnetism in the vicinity.

NEW ELECTRICAL SPECIALTIES.

The accompanying illustrations show several specialties which the Marshall Electric Manufacturing Company, of Boston, Mass., has recently devised and placed on the market. Fig. 15 shows a special angle-wall socket for lighting show windows and other places where incandescent lamps are used with shade-holders. The base of this socket is on an angle, and the shade-holder and shell are made in one piece. They are made both with and without a key, and with a pull mechanism to turn the lamp on and off. Fig. 14 shows a new T. H. locking adapter which, when once screwed into the socket, cannot be readily removed. This is accomplished by a number of spring wings or stops, which bend downward when the adapter is screwed on or forward, but which catch on the porcelain of the socket when turned backward. Fig. 16 shows the new form of snap switch which this company has recently designed. The working mechanism is made of hardened steel, and the mechanical features are decidedly simple. The mechanism consists of a spindle

FIG. 14.

FIG. 17.—GASOLINE SOLDERING IRON AND BLOW TORCH.

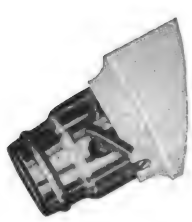


FIG. 15.

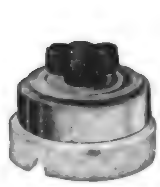


FIG. 16.

with a projecting arm, which fits into a recess in the locking bolt, which, in turn, engages a four-stop ratchet. The springs are of tungsten steel, with phosphor-bronze contacts. The cover—a unique feature of this switch—is lined by a cup of "Elastoid" fibre made in one piece, without wrinkles or seams. The handle is claimed by the maker to be unbreakable. The bases are made both for open and concealed work.

SOLDERING IRON AND BLOW TORCH.

Emmelmann Brothers Manufacturing Company, of Indianapolis, Ind., are introducing a patent combination automatic gasoline soldering iron and blow torch illustrated in Fig. 17, which is one-third the actual size of the tool. The method of operation is as follows: The cap, *A*, is removed and the magazine filled with gasoline within ½ inch of being full; then the cap is screwed on firmly. The alcohol lamp which accompanies each tool, is lighted and the iron is heated at *B* for at least three minutes in a slanting position with the head down, keeping the valve, *C*, closed to generate a hot gas pressure. After heating *B*, the valve, *C*, is gently opened and lighted by passing the tool over the flame at *F*. The tool should continue to be heated at *B* for three minutes more. The operator can regulate the blast to suit the work to be done by means of valve *C*. If the work is being done outside in a heavy wind, or the tool is used as a blow torch, the shutter at *B* should be closed. The soldering copper is universal. Any shape copper point can be used. By removing the copper point shown at *E*, the tool can be used as a blow torch. The tool is furnished with two drop forge coppers; one for regular work and one for heavy work. The head is a high-grade steel casting. The cylinder is made of 16-gauge drawn brass tubing, threaded at both ends. The joints are tinned and sweated, and blunt brass valve stem is used.

GUTHRIE SIGN FLASHER.

Fig. 18 shows the Guthrie sign flasher made by William A. Corrao & Company, of St. Louis, Mo. The flasher is enclosed in an iron box 8 x 5 x 5 ins. and arranged so that it can be readily attached to the wall. The box is lined with ½-in. slate in rear and top. The binding posts are located on the top so that it is not necessary to open the flasher to install it. The flasher is operated by an extra heavy special spring motor, which runs from ten to twelve hours with one winding. All contacts are of platinum and the switches are rated at 6 amperes per switch. All working parts, binding posts, etc., are of brass. A diagram of connections accompanies each flasher.

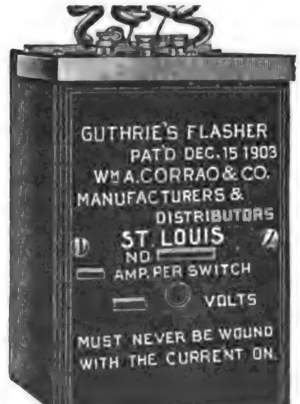


FIG. 18.—SIGN FLASHER.

OTIS FEED-WATER HEATER, OIL SEPARATOR AND FILTER COMBINED.

The accompanying illustration shows the Otis feed-water heater, oil separator and filter combined built by the Stewart Heater Company, of Buffalo, N. Y. This heater consists of a steel shell with cast-iron heads, sustained by four cast-iron legs bolted to the conical bottom, thus making a substantial base for the heater. The exhaust steam enters the heater at the side and passes directly into and through the oil separator, where the oil that is carried over with the exhaust steam from the engine cylinder is separated and passes out at the bottom of the oil separator through the oil discharge pipe. The exhaust steam then passes on into the mingling chamber, where it is brought into direct contact with the spray of cold water, and as the spray of cold water and exhaust steam cannot separate until they both pass out at the bottom of the mingling chamber together, the water is heated almost as hot as the exhaust steam. The exhaust steam then circulates freely through the steam space and passes out at the opening on top. This steam can be used for other heating purposes, if required, as all the water of condensation is said to be deposited in the heater. The feed-water pipe enters the side of shell, turns upward and projects into the mingling chamber, where it terminates in a conical spray nozzle. The spray of water is thus brought into direct contact with the

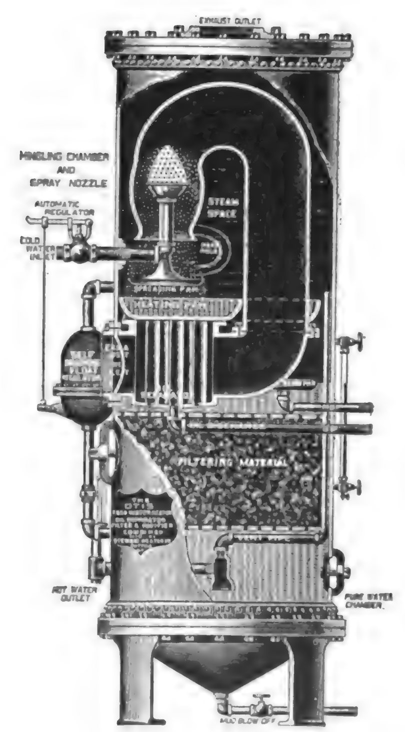


FIG. 19.—OTIS FEED-WATER HEATER AND FILTER.

exhaust steam as it enters the heater, and becomes instantly heated; the heated water then falls upon the spreading cone, where it is again sprayed or spread into the heating pan and flows over its edges before it can mingle with the water in the heater. The heated water is then in the proper condition to deposit the impurities, and as it passes down through the filter or filtering chamber, the clay, sand and other matter in suspension, the carbonate of lime and magnesia in solution, are separated, and the pure water enters the pure-water chamber, which is of large capacity, to allow any particles of sediment that may be in the water to settle in the bottom, where it can be blown out at any time by opening the blow-off valve. The supply of water to the heater is automatically controlled by the float and regulating valve, which keep the water at the proper level in the heater at all times. The float is self-draining or unsinkable, the stem being a brass tube, so should there be any leak, the water could pass off through the stem and the float retain its buoyancy. These floats are made of copper, and are tested to 200 pounds. The float is placed in a separate chamber, attached to the heater shell at the top and bottom, so that any variation in the water level in the heater will cause the float to rise or fall, thus opening or closing the regulating valve, and keeping just the proper amount of water in the heater. The automatic regulating valve is balanced, and is operated with a very slight movement of the float. The filtering chamber is easy of access, and the filtering material can be removed when necessary, and the chamber refilled in a few minutes. None of the scum or oil can get into the boilers, as the pure water is taken from the center of the water chamber, and the hot water or suction pipe to the pump is furnished with a vent pipe, so that should the supply of water be shut off and lower the water in the heater, the pump would stop pumping.

ANDERS PUSH-BUTTON TELEPHONE.

The accompanying illustration shows the various parts of the Anders push-button telephone made by the Edmonstone Company, of New York City. From left to right the parts are as follows: (1) fiber plate for wires to pass through before connecting to metal lugs on telephone; (2) transmitter-base switch, etc.; (3) receiver cap; (4) receiver diaphragm; (5) receiver base, etc.; (6) button cap; (7) button. The receiver is of the watch-case type and is fitted with a bipolar compound magnet. The magnet, pole-pieces, binding posts, etc., are cast solid in hard rubber composition shells so that the adjustment of the pole pieces to the diaphragm is assured. The coils are wound with silk-covered magnet wire over split bobbins, then placed over the pole pieces and held in place by a small nickel cap. This arrangement allows the coils to be changed in case of accident. The back of the receiver shell is fitted with a receptacle for the calling springs and button. A cap is screwed over the receptacle which holds the button in proper relation to the springs which are made of German silver and secured to metal lugs cast in the back of the receiver shell. The transmitter movement is of the solid back type, with self-contained granular carbon and electrode holder of the button type, having a metal diaphragm secured to the front electrode of the button. The base of the transmitter is fitted with an automatic switch, provided with pin-point springs. In the hard rubber composition base are cast metal lugs fitted with machine screws and washers threaded into the lugs for the transmitter and receiver cord, switch and spring connections, also for the bell, line and battery connections, the base being formed and cast as in the case of the receiver. On the face of the transmitter base is a nickel finished metal plate with two ear lugs, to engage the grooved metal ring, which is cast over the receiver cap, holding the receiver in place when same is not in use. The placing of the receiver in the ear lugs engages the lever of the automatic switch, which in turn changes the circuit springs on the back of transmitter base, cutting out the transmitting and receiving circuits, and cutting in the signal bell circuit. There is a small fibre disk fitted in the back of each transmitter base, which disk has a number of holes that correspond to the lugs in the base to which the various wires are to be connected. The disk is also for protection of the transmitter button, switch, spring connections, etc., and when in place (after the wires are connected) rests on a small inverted rim. The disk is further supported by four small posts, one on each side of transmitter button and one on each side of the switch springs, in back of the transmitter base. The following are the dimensions of complete telephone over all, consisting of transmitter, receiver and connecting lugs: diameter, 3½"; depth, 2¼"; depth of telephone over all, mounted on intercommunicating switch block of the wall type is, 3¼". The telephones for all systems are identical as to outward appearance, construction and material used and are wired and fitted for the following systems: straight line, intercommunicating, switchboard or return call annunciator, central station and selective ringing common battery systems. Complete wiring diagrams, showing connections of the systems, accompanying each instrument.

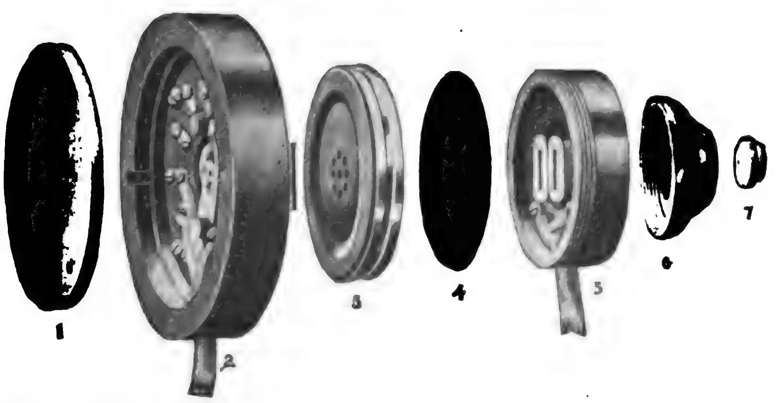


FIG. 20.—TRANSMITTER AND RECEIVER OF ANDERS PUSH BUTTON TELEPHONE.

SANGAMO WATT-HOUR METERS FOR DIRECT CURRENT.

Fig. 21 herewith illustrates the new Sangamo watt-hour meter made by the Sangamo Electric Company, of Springfield, Ill.

FIG. 21.—SANGAMO WATT-HOUR METER.

The rotating element of this meter, which is of the mercury contact type, is a heavy copper disc immersed in mercury and enclosed in a box of specially formed insulating material which is said to be both hard

FIG. 22.—SANGAMO WATT-HOUR METER.

and durable. In the walls of this chamber are embedded copper contact ears shown in Figs. 21 and 23 and connected outside by knurled adjusting nuts to flexible cables carrying the main current. Two powerful

magnetic fields cause rotation of the disc. The fields are due to two soft iron poles embedded in the lower half of the disc chamber wall, and energized by the series and shunt coils. These same fields are also used as damping magnets to govern the speed of the meter, so that no permanent magnets are used. To overcome in a measure the buoyant effect of the mercury of the disc, a counterweight is attached to the disc shaft in an upper part of the insulating casing. This weight being a trifle less than the buoyant effect of the mercury permits of a slight thrust against the jewel in the upper bearing of the meter. This bearing

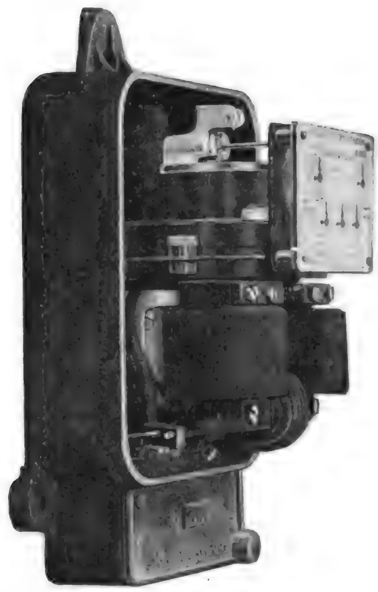


FIG. 23.—SANGAMO WATT-HOUR METER.

carries a flat jewel, and has a fine screw adjustment to give the disc just the contact pressure desired. When the adjustment is complete, the bearing is held in position by a small screw. Owing to the strong field and small air gaps, external magnetism is said to have no effect on the meter. An iron return plate above the disc and the iron back of the meter also act as an effective shield. The meter is sealed in the case after being tested, and need not be removed, as the mercury is shipped in the disc box and the spilling of it is prevented by the design of the opening through which the disc shaft passes to the outer upper bearing. A pocket is provided, into which the mercury flows when the meter is turned over, and when the meter is placed upright and in position, the mercury returns to its proper place. The meter is adjusted by sliding the connecting nuts back and forth on the copper disc box ears, thus altering the distribution of current through two paths in the disc having different torque effects. The light load adjustment is very simple and may be easily made. A high resistance rod, shown below the shunt magnet in Fig. 22, has a sliding connector on it which is in contact with the ingoing shunt wire. By altering the position of this wire along the rod, the small current passing to the shunt coils is divided between two paths, one through the disc and back to the connector through the right end of the rod, and the other directly from the in post through the left end of the rod. That portion of the current passing through the disc tends to produce some rotative effect, and this effect is varied by moving the sliding connector from the left to right of the resistance rod. The meter is 9 ins. high, 5½ ins. wide, and projects 4¾ ins. when installed. The case may be of aluminum or glass, the meter with the former covering weighing 10 lbs. For 110 and 220-volt maters, all resistances are placed in the case; for 500-volt meters the resistance tubes are placed in a small perforated cast-iron box, which may be placed near the meter. All meters up to 40 kilowatts capacity read directly in watt-hours; larger sizes require a multiplier.

NEW VARIABLE SPEED MOTOR.

The Crocker-Wheeler Company, of Ampere, N. J., has brought out a new line of variable speed motors, one of which, with its controller and resistance, is shown by Fig. 24 herewith. The line is complete for single voltage circuits of 115 and 230 volts, and the speed variation is obtained by field regulation alone. The general design of these motors is such as to adapt them readily to machine tool application. The bearings are of the ring oiling type, thoroughly protected from the intrusion of dust and dirt. The pole pieces are of cast steel to which are fastened pole shoes holding the field coils in place. The coils are carefully wound and insulated, the outer surface being covered with stout insulation coated with varnish as a protection against dirt and dampness. These motors are arranged in two classes, the first being adapted to give constant horse-power throughout a speed range of 2:1, and the second being arranged to give a constant horse-power throughout a speed range of 3:1. Both of these classes are designed for operation on a single voltage of either 115 or 230 volts. In order to adapt these motors more thoroughly to the requirements of the machine tool builders, the classes are divided into two groups, the group comprising the smaller sizes of motors being designed to operate at a maximum speed of 1600 r.p.m., and the group comprising the larger sizes at a maximum speed of 1400 r.p.m. These speeds have been selected as being the highest at which it is considered good practice for the motors to operate. The advantage of having the motors thus grouped as regards speed ranges will readily be appreciated by the tool builders, as they are thus afforded a choice in the power of the motor which may be applied to a given tool without the necessity of altering their speed mechanisms to suit the varying speeds which are usually involved in a change of motors. For use with these motors full reverse controllers of the drum type are usually supplied, which are used for starting the motors and for weakening the fields up to maximum speed. The company states that in putting this variable speed motor on the market it is in no way disloyal to its multiple-voltage system which has become thoroughly established; but in certain classes of equipment the installation of the multiple-voltage system is often not warranted.

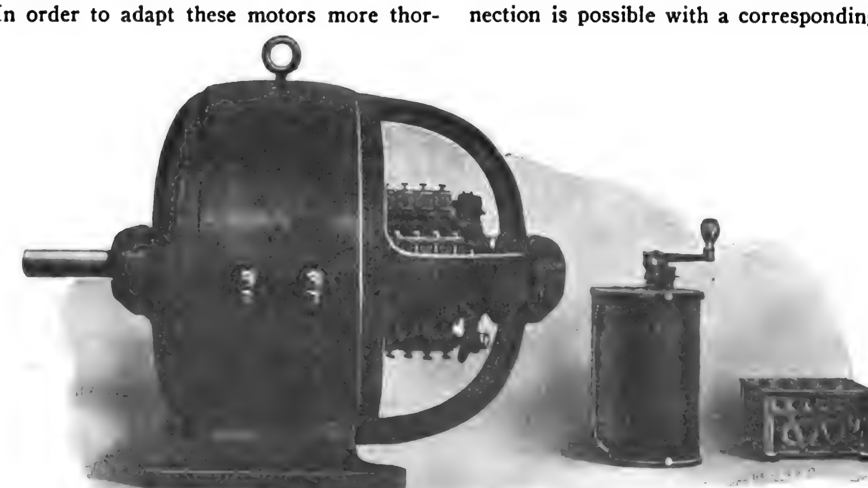


FIG. 24.—CROCKER-WHEELER VARIABLE-SPEED MOTOR.

DOSSERT TERMINALS.

The principle of the Dossert joint can be applied to any device for making electrical connections. In places where lugs for soldered joints are now used, the regular

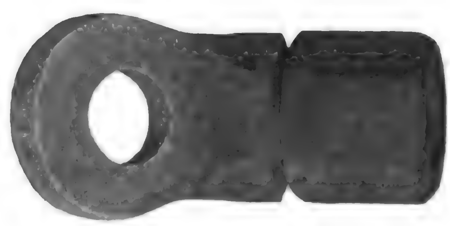


FIG. 25.—DOSSERT BENT LUG.

Dossert nipple and nut are ready substitutes, these being used in place of the ordinary receptacle into which the cable is soldered. As is probably well known, no solder is used in the Dossert joint, so that a great reduction in the time required to make the connection is possible with a corresponding reduction in cost. For example, the manufacturers state that a Dossert joint connection for a 1,000,000 cir. mil cable can be made by one man in seven minutes, which is evidently a much shorter time than would be required to make the soldered connection. The gain in this respect is, of course, greatest with the largest cables. Fig. 25 shows

a Dossert bent lug designed for special switchboard connection. The joint will accommodate a 1,000,000 cir. mil cable. Lugs of this type have been installed in one of the large public buildings of New York City. Figs. 26 and 27 show the assembly and one of the parts of a lug designed for

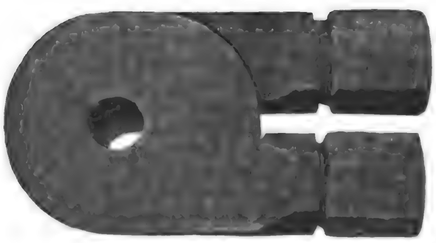


FIG. 26.—DOSSERT TWIN LUG.

one of the generators being installed in another large public building in this city. The lug is made in two parts to permit a swivelling motion about the centre bolt in order to line up the connections with the incoming cables. The combined carrying capacity of the cables is about 1200 amperes. It might be interesting to note that at the recent meeting of the National Board of Fire

FIG. 27.—PART OF TWIN LUG.

Underwriters, held in New York, the Dossert joint received favorable consideration. Its use was not approved unqualifiedly, since the opinion was expressed that the behavior of the joint in the field of everyday practice, where it would be subjected to all kinds of conditions and abuse, should first be ascertained. In order to obtain this information permission had, of course, to be given for its use. This permission is subject to the discretion of the local Boards of Fire Underwriters, who, before giving it, must be informed just where the joints are to be used. The devices are made by Dossert & Company, of New York City.

ATLAS WATER-TUBE BOILER.

The American water-tube boilers recently purchased by the Japanese Government for use in reconstructing the docks at Port Arthur, are of a new type, differing very radically in many particulars from the older types of water-tube boilers. The boiler is composed of a nest of tubes, set on the ordinary incline between water legs, and three drums running across the tubes instead of lengthwise at the top. The front and rear drums, together with their water legs, are each made of two plates, riveted at the top of the drum and at the bottom of the leg. This method of construction enables the builders to eliminate seams next to the fire or hot gases, since the only seam in each of these legs is at the bottom, where it is protected by the masonry, while the seams of the drums are located on the top, away from the fire. This method also gives a full length opening at the throat, where the water passes between the leg and drum. The throat is braced with a patent twisted brace which leaves over 80 per cent of the area open. The rear drum contains a mud pan through which the feed-water flows and where practically all the impurities of the water are said to be precipitated. A connection from the bottom of the pan through the drum head permits the precipitation to be blown out. This mud pan or purifier is built in sections and can be removed through the manhole and renewed at small expense when it becomes pitted. The mud pan occupies small space and there is considerable generating surface in this rear drum. The fresh water from the purifier flows down through the rear leg and up through the tubes and front leg to the front drums, where there is a large releasing surface. The two drums are connected by straight equalizing tubes, arranged in three tiers along the ordinary water line. Each of these drums is connected with a middle drum by tubes and the steam as it is released, travels through these tubes to the middle drum, from which it is taken for use. The builder states that experience has shown that by thus carrying the steam to a third drum through tubes exposed to the furnace gases, not only is perfectly dry steam obtained, but this steam is given superheat, varying from 10 to 22 degrees, according to the state of the fire. Since all the tubes carrying water are straight and readily accessible, the boiler is easily cleaned. The boiler is built by the Atlas Engine Works, Indianapolis, Ind.

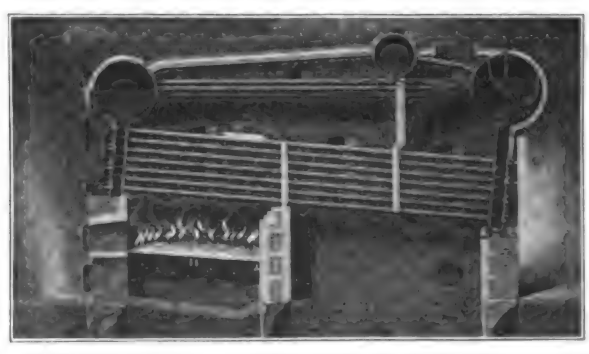


FIG. 29.—ATLAS WATER-TUBE BOILER.

CARPENTER'S NEW FULL MOUNTED DIE STOCKS.

Fig. 28 herewith shows a new full mounted set of dies and taps made by the J. M. Carpenter Tap & Die Company, of Pawtucket, R. I. Each assortment has a stock

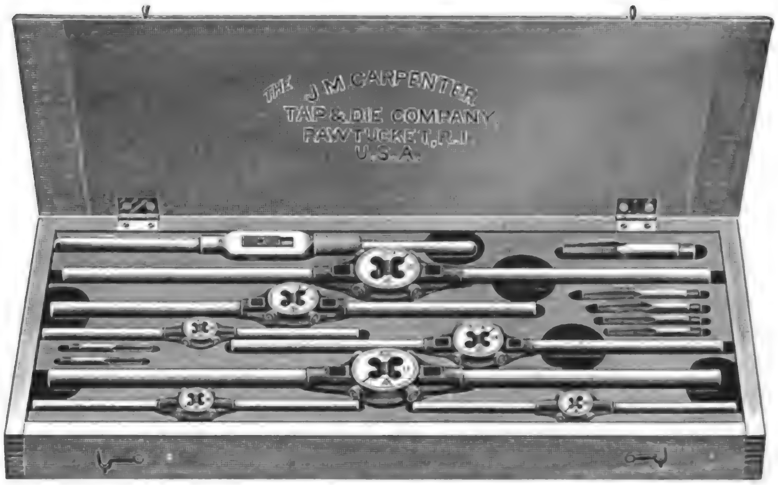


FIG. 28.—SET OF FULL MOUNTED DIES AND TAPS.

for each die and Nichols' adjustable tap wrenches for holding all sizes of taps contained in assortment. The set is put up in a hardwood case as shown. The set shown is known as No. 80. It is made up in three styles; one set containing V thread standard sizes; another, rough iron sizes, and the third, U. S. standard thread sizes. The company, of course, make any kind of combination desired. The contents of each No. 80 set is as follows: V Standard sizes.—Cutting, 1/4 x 20, 5/16 x 18, 3/8 x 16, 7/16 x 14, 1/2 x 12, 5/8 x 11, 3/4 x 10, with a No. 1 Nichols' patent tap wrench and a stock for each die. Rough Iron Sizes.—Cutting, 9/32 x 20, 11/32 x 18, 13/32 x 16, 15/32 x 14, 17/32 x 12, 21/32 x 11, 25/32 x 10, with a No. 1 Nichols' patent tap wrench and a stock for each die. United States Standard.—Cutting, 1/4 x 20, 5/16 x 18, 3/8 x 16, 7/16 x 14, 1/2 x 13, 5/8 x 11, 3/4 x 10, with a No. 1 Nichols' patent tap wrench and a stock for each die.

PORTABLE WATT-HOUR METER CALIBRATORS.

The Ft. Wayne Electric Works, Ft. Wayne, Ind., have brought out a ringing and a registering watt-hour meter calibrator for use in calibrating watt-hour meters

FIG. 30.—REGISTERING CALIBRATOR.

without removing them from service and without expending more than a few minutes in their calibration. The ringing calibrator is shown by Fig. 31 herewith. A standard "Type K" watt-hour meter of proper capacity, voltage and frequency, but without the recording mechanism is mounted on the inside of a wooden carrying case. The case is provided with leveling screws and a small spirit level set into the base. In the case is also a double-pole double-throw switch by means of which the series coils of the standard can be connected either in multiple or in series for double or normal rated current. This prepares the calibrator for use with 5 and 10

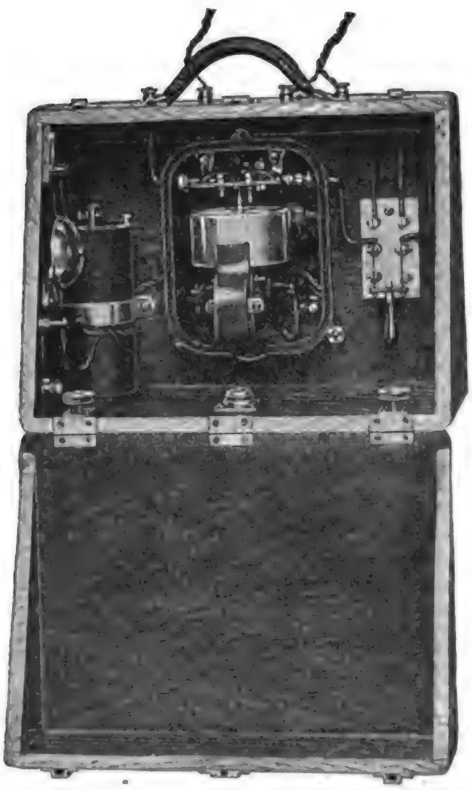


FIG. 31.—RINGING CALIBRATOR.

ampere meters by direct comparison without a speed constant, the change in connections making no change in total ampere turns or speed. The scope of the calibrator is further magnified by using a speed constant of 2 for calibrating 15, 20 and 25-ampere "Type K" meters. For comparing the speeds of the two meters, a bell circuit is connected with the standard through a two-segment commutator on its armature shaft in place of the registering train. At every revolution of the standard armature the bell circuit is closed through a dry battery mounted on the left side of the case. This bell circuit may be permanently opened when not in use by a two-point switch. The dimensions of the case are 15 by 11 by 8 ins. The registering calibrator shown in Fig. 30 consists of a "Type K" meter, having the regular registering train replaced by a double reduction train and two dials instead of five. The dials register revolutions instead of kilowatt-hours. This is a much simpler device than the ringing calibrator, but is much more restricted in its adaptability. Two adjustng screws are provided on the bottom of the frame for leveling it for use, the third support being on the bottom of the case. The jewel bearing screw is extra long, and projects through the case at the bottom so that the shaft can be raised or lowered without removing the case which can be sealed and the adjustment of the standard protected from outside disturbances. The calibrator terminals can be reached by removing the terminal cap. The dials of the calibrator will register 110 revolutions, which is equivalent to nearly three minutes' running at full load. If the revolutions of the meter to be tested be counted and compared with the difference in calibrator readings before and after counting an exact oomparison of speeds is obtained.

SUCCESSFUL DEVELOPMENT FROM AN UNPRETENTIOUS START.

In the year 1874, Mr. J. D. Cox, in a very modest way, established himself in Cleveland, for the manufacturing of tools. Five years later, Mr. F. F. Prentiss joined him as partner. For twenty-five years this partnership went on uninterrupted and was known to the business world as "Cleveland Twist Drill Company." During this period, by careful management and under the constant ambition to produce tools of the highest quality, the business prospered, until to-day its product is found wherever machinery is built. The immense factory, built up as increased business demanded, and equipped with special and modern machinery and appliances, further attests the result of successful business methods.

After thirty years of constant activity, Mr. Cox has decided that he has earned a little rest and relief from responsibility, which decision was strengthened by health considerations, and with this in view, the parnership was merged into a stock company on December 31, 1904, under the name of the Cleveland Twist Drill Company. Before transferring the partnership affairs to the stock company, several of the old employees were invited to take stock, and this opportunity was readily accepted by all to whom the privilege was accorded.

While Mr. Cox will be relieved of active duties, he will retain his large holdings in the business, and also serve in the capacity of vice-president and director. The other officers of the company are: F. F. Prentiss, president and general manager; E. G. Buckwell, secretary, and George F. Kast, treasurer. Notwithstanding that this change has taken place, the personnel of the company remains intact, and the business and manufacturing policies of the past will be maintained in the future.

FORT WAYNE ELECTRIC WORKS CONVENTION.

The Fort Wayne Electric Works is one of the oldest concerns in this country now engaged in the manufacture of electric lighting and power apparatus. It is probably best known as the manufacturer of the "Wood" systems of electric lighting and power which may be found in use in many plants in this country.

The extent of territory covered by the sales organization reaches from Boston to San Francisco, and from St. Paul to Atlanta. The modern methods of the company are well illustrated by the periodical conventions of the district managers of the various sales territories and the home office organization. The last convention was held from January 10 to 13, of this year; the daily business sessions of the convention were relieved by evening social functions of a very enjoyable nature. Representatives from Boston, New York, Philadelphia, Syracuse, Pittsburg, Atlanta, Cincinnati, Grand Rapids, Chicago, St. Paul and St. Louis were present.

The closing feature of the convention was a banquet at the Anthony Wayne Club, at which over fifty of the sales force were present. The banquet was presided over by Judge R. S. Taylor, who has been counsel for the company since its infancy. Guests from the city included the local directors and others interested in local electrical organizations.

During the evening the district managers, as an expression of their appreciation and esteem for the one who is responsible for the products they handle, presented Mr. J. J. Wood with a handsome loving cup through their spokesman, Mr. W. S. Goll, manager of the Chicago office. Mr. Wood has been with the Fort Wayne Company since 1890, when he went to Fort Wayne from Brooklyn, when the Fort Wayne Company purchased the Brooklyn plant, then manufacturing Mr. Wood's arc lighting apparatus. He immediately assumed charge of designing new electrical apparatus and redesigning the old apparatus and electrical devices already in production by the company. That Fort Wayne apparatus is now in such extensive use is due primarily to the high degree of Mr. Wood's ability as a designer. It was in recognition of this that the district managers of the company presented him with the loving cup.

THE AUTOMOBILE SHOW.

The fifth annual automobile show, held January 14-21 last, at Madison Square Garden, was by far the most successful one that has thus far been held. Every available square foot of the enormous space was occupied, and the indications were that a much larger exhibition hall could have been filled. The exhibition was noteworthy for solid improvement in construction and a far smaller proportion of freaks than has been the case in previous years. The French type of vehicle predominated largely, and a very great improvement in the touring car style is noticeable in the use of side-opening doors to the rear compartment instead of the dangerous and inconvenient door at the extreme rear of the car, which has been heretofore universally employed. The use of a side door, of course, involves the use of a longer wheel-base, and in most cases the means of entrance to both the front and rear seats consists of a broad running board or platform instead of the usual restricted individual steps.

Among the gasoline cars, the four-cylinder type was by far the favorite; in this exhibition there were about 130 cars of this type and less than one-tenth this number of the two-cylinder type, and there were still fewer of the other types. It is also noteworthy that the two-passenger runabout form of vehicle, which was so popular last year and previously, appears to be losing ground. The large majority of vehicles in the present exhibition were for four or more passengers. The number of electric vehicles was relatively small in comparison with the gasoline type, which is, of course, natural, in view of the limited radius of action of the electrical type. Only six companies exhibited electrical vehicles, namely: The Vehicle Equipment Company, the Studebaker Automobile Company, the Electric Vehicle Company, the Baker Motor Vehicle Company, the Pope Motor Car Company, and the National Motor Vehicle Company.

There were, of course, a number of exhibits of electrical auxiliaries, such as induction coils, batteries, ignition dynamos, spark plugs, etc. Among the exhibitors of these specialties were: the American Coil Company, Somerville, Mass.; American Electrical Novelty & Manufacturing Company, New York; Atwater Kent Manufacturing Company, Philadelphia; Auto-Coil Company, Jersey City; Constant-Spark Plug Company, Boston; Crest Manufacturing Company, Dorchester, Mass.; Dayton Electrical Manufacturing Company, Dayton, Ohio; Dow Portable Electric Company, Braintree, Mass.; Eastern Carbon Works, Jersey City; Electric Contract Company, New York; Motsinger Device Manufacturing Company, Pendleton, Ind.; National Carbon Company, Cleveland, Ohio; New York Coil Company, New York; William Roche, Standard dry batteries, New York; Pittsfield Spark Coil Company, Pittsfield, Mass.; Polyphase Ignition System Company, New York; Remy Electric Company, Anderson, Ind.; Rushmore Dynamo Works, Plainfield, N. J.; C. F. Splitdorf, New York; Standard Welding Company, Cleveland, Ohio; United Electrical Manufacturing Company, New York, and Warner Instrument Company, Beloit, Wis.

NEW BOOKS.

ALTERNATING CURRENTS. By George T. Hanchett. New York: John Wiley & Sons. Cloth; 180 pages, 5 inches x 7¼ inches; numerous illustrations. Price, $1.00.

This is a highly meritorious effort to present an exposition of alternating-current principles which will be intelligible to students and others who either have not had sufficient mathematical training or have not the time and inclination to master heavier text books, such as those of Dr. Steinmetz. The author is a thoroughly trained practising engineer and knows his subject; his treatment of it is practical and full of common sense, and the book should be of much value to those for whom it was written. There are some little obscurities of diction, but in the main the work is clean-cut and easily followed.

ELECTRICAL ENGINEERING. By E. Rosenberg. Translated from the German by W. W. H. Gee and Carl Kinsbrunner. New York: John Wiley & Sons. Cloth: 270 pages, 5½ ins. x 9 ins.; 263 illustrations. Price, $1.50.

Thus is a semi-popular elementary book, containing a good deal of general information concerning electrical apparatus and its uses, but very little educational materal. It should serve excellently the purpose of anyone who desires to acquire merely a casual knowledge of the subject without desiring to pursue the study seriously.

NORTHWESTERN CONVENTION NOTES.

Quite a number of manufacturing and supply houses were represented at the annual convention of the Northwestern Electrical Association held in the Hotel Pfister, Milwaukee, on January 18 and 19, and many of these made exhibits in parlors.

Porter & Berg, Chicago, had an interesting exhibit in the corridor of the hotel consisting of Locke high-tension insulators.

Julius Andrae & Sons Company, Milwaukee, exhibited the various lines handled by it, including the G. I. and Westinghouse products.

The Wagner Electric Manufacturing Company, St. Louis, received its visitors in one of the parlors and distributed literature pertaining to its products.

The Fort Wayne Electric Works, Fort Wayne, Ind., took up headquarters in one of the parlors where an exhibit was made of the well-known arc lamps made by the company.

The Federal Electric Company, Chicago, displayed its enameled steel electric signs, some of which were flashed with Dull's flashers which were exhibited in the same room.

The Electric Storage Battery Company had its representatives stationed in the southwest parlor where they received the friends and patrons of the company and distributed advertising literature.

The Western Display Company, St. Paul, had a large "Reflectric" sign displayed in a prominent position in the hall. This sign is of enameled steel with lights concealed in reflectors above the sign.

The Allis-Chalmers-Bullock interests distributed a handsome souvenir badge and watch charm having the company's "ours the four powers" design. Visitors were entertained in one of the parlors and printed matter was distributed.

The Duncan Electric Manufacturing Company, Lafayette, Ind., exhibited a number of its meters and had placards posted throughout the hotel calling attention to the exposed jewel features of the meter.

The Benjamin Electric Manufacturing Company, Chicago, had an exhibit in connection with the exhibit of the Holophane Glass Company. The company's new wireless cluster "Arc Burst" was shown with lamps equipped with Pagoda reflectors.

The Nernst Lamp Company had a number of its lamps on exhibition which, however, were not lighted, owing to the fact that alternating current was not available at the hotel. The construction of the lamp was clearly shown in the disassembled parts.

The General Electric Company made its headquarters in the southeast parlor. A number of recent types of circuit-breakers made by the company were on exhibition. Printed matter relating to the company's many and varied products was distributed.

The Crouse-Hinds Company, Syracuse, N. Y., exhibited its new receptacles for sign and decorative work. The receptacles were made up to resemble a porcelain insulator and the board upon which these were fastened also contained some of the company's switches and outlet boxes.

The Holophane Glass Company, New York, had one of its demonstrating outfits set up in one of the parlors. This was in charge of C. A. Howe, general sales manager, and H. E. Watson. The comparative amount of useful light obtained with and without the use of Holophane globes was forcibly shown, as well as the superiority of the Holophane over other forms of globes.

The National Electric Company, Milwaukee, made special arrangements for the reception and entertainment of its friends at the convention. A handsome exhibit was set up in one of the parlors and some bromide enlargements hung on the walls gave an excellent idea of some of the larger electrical machinery made by the company. A publication entitled the "National Electrical Catechism" was presented to each visitor; this is the latest advertising literature of the company, and is extremely interesting. Of special interest to the visitors was the Lundell "Universal" motor, of which the special feature of construction is a field magnet composed entirely of laminations. Other features of novelty are comprised in this motor, which is unique in many particulars; among these may be mentioned an improved brush-holder and also the improved design by which commutation is obtained over an exceptionally wide range. Invitations, which included a pass over the street railway system, were given to the members of the Association to visit the works of the National Electric Company, which are pleasantly situated at the northeastern part of the city. A souvenir watch charm was also distributed.

OBITUARY.

E. H. MULLIN.—As we go to press we learn with extreme regret of the sudden death on January 25th of Edward H. Mullin, of the General Electric Company's advertising department. Mr. Mullin had been in rather poor health for a few weeks prior to his death, but was not considered seriously ill. He had remained at home during his

THE LATE EDWARD H. MULLIN.

indisposition more as a precautionary measure than because of physical inability to get about, and expected, on the last day of his life, to get back to his office within a day or two. His death, which was apparently due to heart trouble, occurred without the slightest warning while he was reading

aloud to his wife. Mr. Mullin was born in Castlederg, Ireland, October 22, 1859. His early education was received at Methodist College and Queen's College, Belfast, and he took the degree of B. A. in an honor course in Physics and Chemistry in Queen's University in 1881. Shortly after this he came to this country and in 1887 joined the New York *Sun's* staff; in 1895 he left the *Sun* and took charge of the technical reportorial work of the *Times*. From 1895 to 1898 he contributed to many literary and technical publications. Early in 1898 he joined the New York staff of the General Electric Company, taking charge of the relations between that company and the technical press, and he occupied this position up to the time of his death. He leaves a widow.

PERSONAL.

MR. A. L. ENGLISH has been appointed manager of the Citizens' Gas & Electric Company, Council Bluffs, Ia.

MR. ALEXANDER WEBB, of New York, has been elected treasurer of the Youngstown (O.) Consolidated Gas & Electric Company.

MR. EDWARD MILLER has been appointed manager of the promotion department of the Cincinnati Gas & Electric Company, Cincinnati, to succeed Mr. H. C. Hutchinson, who resigned recently.

MR. W. B. ELLIOTT, who for several years has been works manager of the C. & C. Electric Company, has been appointed general manager of the company to succeed Mr. Campbell Scott, whose resignation was noted in this column last month.

MR. W. S. KEMP, for the past ten years treasurer of the Brookline National Bank, has been elected secretary and treasurer of the Holtzer-Cabot Electric Company, Boston, Mass., succeeding Mr. Ira A. Foster who recently resigned the joint position.

MR. HENRY C. MORTIMER, JR., formerly of the General Electric Inspection Company, recently severed his connection there to join the New York staff of the Crocker-Wheeler Company, as assistant to Mr. F. B. De Gress, manager of the New York office.

MR. C. J. PURDY, for some time past New York sales agent of the Munder Electric Company, recently resigned that position to accept the general managership of the American Incandescent Lamp Company. Mr. Purdy's headquarters are at 26 Cortlandt Street, New York.

MR. ALFRED J. THOMPSON, who was connected with the sales department of the Crocker-Wheeler Company for some time, has joined the forces of the Allis-Chalmers Company and will devote his time to the sales of the Bullock lighting and power apparatus in New York and vicinity.

MR. EDWARD VAN WINKLE, formerly associated with Mr. Charles R. Pratt in consulting engineering, has established offices at 160 Fifth Avenue, New York, and will continue alone in the same line of work, Mr. Pratt having retired from consulting engineering to devote his entire time to his elevator safety devices.

MR. GEORGE MAGALHAES, who has been for some time on the engineering staff of the Electric Controller & Supply Company, Cleveland, Ohio, has been appointed manager of that company's eastern office at 136 Liberty Street, New York. Mr. Magalhaes is a graduate of Columbia University and is thoroughly familiar with all of the company's products.

MR. FRANK FERGUSON, a well-known builder of boilers and engines, and Mr. Daniel Killion, well known in the electrical field, have organized a company under the style of Ferguson & Killion Company, Inc., for the purpose of building boilers, engines, electric machinery and complete power plants. The headquarters of the new company are in the Betz Building, Philadelphia.

MR. ARCHIBALD B. BUSH, for many years connected with the sales department of Manning, Maxwell and Moore has severed his connection with that house and has taken up the Eastern sales agency of The Hisey-Wolf Machine Company, of Cincinnati, Ohio, manufacturers of portable electric driven grinders and drills. Mr. Bush's headquarters will be at 120 Liberty Street, New York City.

MR. W. S. MONTGOMERY, who was for several years manager for the Conover Condenser Company, and during the past year manager of the Payne Engine Company's New York Office, has resigned the latter position to form a partnership with Mr. G. M. Rogers, under the style of Rogers & Montgomery, for the purpose of handling small labor-saving tools and hardware specialties. The new firm's offices are at 147 West 23rd Street, New York.

MR. CHARLES R. UNDERHILL, formerly chief engineer of the Varley Duplex Magnet Company, has engaged in consulting engineering on his own account, with headquarters at 55 Liberty Street, New York. Mr. Underhill will make a specialty of the design of electromagnets and solenoids in general, but particularly for heavy-duty work. He will also take contracts for the complete construction of magnets and solenoids to perform a given duty.

MAJ. GEORGE O. SQUIER, of the United States Signal Corps, recently made an exhaustive report to the Chief Signal Officer of the California Department on the absorption of magnetic waves by living vegetable organisms, the report being based on an incident which occurred at a joint encampment of regular troops and organized militia at American Lake, Wash. The report has been published in pamphlet form and makes extremely interesting reading.

MR. JAMES G. ROBERTSON, who has represented A. L. Ide & Sons at St. Paul, Minn., for the past 15 years, has been appointed manager of the New York office of that firm and will push the sale of Ideal engines in the East. Mr. Robertson has established headquarters in the Bowling Green Building, New York, and his staff thus far includes Mr. G. B. Ferrier, Jr., and Mr. Stewart G. Fuller. The western Ide office has been put in charge of Mr. Robertson's brother, Mr. A. R. Robertson.

MR. E. S. LEA, who made many friends in his position as sales manager for the De Laval Steam Turbine Company, has resigned that position and established headquarters at 42 Broadway, New York, as a consulting engineer. Mr. Lea has had wide experience in the design and construction of power plants and water works plants, as well as in the manufacture of machinery. He is a member of several technical bodies, including the American Institute of Electrical Engineers and the American Society of Mechanical Engineers.

TRADE PUBLICATIONS.

MULTIPLE-DUCT CONDUIT. Standard Vitrified Conduit Company, New York.—A handsomely executed folder containing illustrations of multiple-duct conduit and third-rail insulators.

OIL SWITCHES AND CIRCUIT-BREAKERS. Westinghouse Electric & Manufacturing Company. —Circular No. 1096, containing illustrated descriptions of oil circuit-breakers and oil switches, both manually and electrically operated.

RESISTANCE MEASURING INSTRUMENTS. Queen & Co., Inc., Philadelphia.—A bulletin of standard resistance boxes, resistance coils, slide-wire bridges, cylindrical bridges, Thomson portable bridges, portable testing sets and rheostats.

ELECTRICAL SPECIALTIES. Trumbull Electric Manufacturing Company, Plainville, Conn.—Catalogue No. 5, of standard size, devoted to Trumbull switches, fuse blocks, connectors, receptacles, rheostats, cut-outs, panelboards and cabinets.

CALENDAR. The Triumph Electric Company, Cincinnati, Ohio.—A hanging calendar, comprising an extremely attractive picture executed in colors on a heavy cardboard mount and a pad calendar attached to the mount beneath the picture.

HOISTING AND CONVEYING MACHINERY. McMyler Manufacturing Company, Cleveland, Ohio.—A well-executed catalogue of standard size, containing illustrations of cranes, derricks, conveyors, and other hoisting and conveying apparatus built by this company.

DENTAL LATHE MOTORS. The Holtzer-Cabot Electric Company, Boston, Mass.—A pocket-size pamphlet containing a very full illustrated description of the line of small machines indicated by the title. These are built in both alternating-current and direct-current types.

STEAM SPECIALTIES. Penberthy Injector Company, Detroit, Mich.—Catalogue No. 21, of standard size, containing very full illustrated descriptions of Penberthy injectors, foot valves, ejectors, steam rams, mufflers, low and high-water alarms, water gauges, force-feed oil pumps, oil cups, etc.

CALENDAR. National Carbon Company, Cleveland, Ohio.—A hanging calendar, carrying on the cardboard backing a well executed half-tone picture of a handsome woman, beneath which is attached a pad calendar differing from the usual form in that each monthly leaf contains a moonlight lighting schedule for that month.

FEMCO INCANDESCENT LAMPS. The Franklin Electric Manufacturing Company, Hartford, Conn.—A well-executed pamphlet of pocket size, containing illustrations and specifications of all of the standard incandescent lamps manufactured by this company. The company has recently added to its line some reflector lamps, the reflector in which is removable.

SWITCHBOARDS FOR SMALL EXCHANGES.—The North Electric Company, Cleveland, Ohio.—Bulletin No. 26, containing an illustrated and full detailed description of switching stations for small or isolated telephone exchanges. The information contained in the bulletin is unusually complete and includes a full diagram of circuit connections.

THE INSULATOR BOOK. The Locke Insulator Manufacturing Company, Victor, N. Y.—Catalogue No. 8, of standard size, containing illustrations and data relating to the complete line of Locke porcelain and glass insulators for electric light and power service. The catalogue also contains some interesting notes on the testing and manufacture of insulators.

WHAT THE HINDOOS DO. The Buckeye Electric Company, Cleveland, Ohio.—An illustrated folder, pointing out the Hindoo custom of following up a messenger to make sure that he discharges the duty with which he is entrusted, the application being that the Buckeye Company systematically follows up its customers and keeps them posted as to the merits of Buckeye lamps.

BALL BEARINGS. The Hess-Bright Manufacturing Company, Philadelphia.—Catalogue No. 68, of standard size, containing illustrated descriptions and tabulated data relating to a special form of ball bearing manufactured for heavy-duty work. This form of bearing is used on dynamos and motors of a good many European manufacturers and is coming more and more into use in this country.

CALENDAR. The Holtzer-Cabot Electric Company, Boston.—An attractive and most sensible form of calendar, consisting of three sheets of heavy cardboard linked together by cords; the upper sheet bearing pictures of Holtzer-Cabot motors, the middle sheet carrying a pad calendar, which is also illustrated by pictures of various Holtzer-Cabot apparatus, and the lower sheet containing pictures of the factory and some of the company's telephone apparatus.

VARIABLE SPEED MOTORS. Electro Dynamic Company, Bayonne, N. J.—Circular No. 1-B, containing an illustrated description of the company's inter-pole direct-current motor for variable speed service. This machine is provided with small intermediate magnet poles which supply a commutating field and permit the weakening of the main field without sparking. The description is exceptionally well written and technically accurate.

BUSINESS NEWS.

THE WIRT ELECTRIC COMPANY, INC., of Philadelphia, has removed its New York office to 15 Cortlandt Street.

THE SHEPHERD ENGINEERING COMPANY, Franklin, Pa., has been awarded a gold medal for its engines by the Louisiana Purchase Exposition.

HOLOPHANE GLASS COMPANY has consolidated its Chicago and New York offices in the Glackner Building, 227 Fulton Street, New York.

THE BRISTOL COMPANY, Waterbury, Conn., has been notified by the St. Louis Exposition officials of the award of a gold medal for its exhibit of recording instruments.

A. L. IDE & SONS, the well-known builders of the Ideal steam engines, have established eastern headquarters at 11 Broadway, New York, through which all export, New England and Middle States business will be transacted hereafter.

THE WILLIAM TOD COMPANY, Youngstown, Ohio, has received a contract for a new pumping engine for the Kansas City (Mo.) water works; the cost of the engine will be about $140,000.

THE LAGONDA MANUFACTURING COMPANY, Springfield, Ohio, makers of the well-known Weinland tube cleaners, reports a most encouraging business outlook for the present year. The company's business during December was the largest of any single month since it was organized.

PITTSBURG GAGE & SUPPLY COMPANY, Pittsburg, Pa., has been compelled by the growth of its business to enlarge its quarters, and has accordingly leased another store and warehouse at 321 Water Street, adjoining its present warehouse. The new building is four stories high and covers a plot 50x200 feet.

THE WESCO SUPPLY COMPANY, St. Louis, Mo., has established a branch office and warehouse at Fort Worth, Tex., for the convenience of its southwestern trade. The new office is in charge of Mr. V. E. Raggio, previously sales manager of the company. A complete stock of apparatus and supplies will be carried at the Fort Worth branch.

CENTURY ELECTRIC COMPANY, St. Louis, Mo., has just moved its main office and works from 1007 Locust Street to 404 North Fourth Street, where much larger and more suitable quarters have been obtained. The move was rendered necessary by the rapid increase in the company's ceiling fan and power motor business.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., has established a branch office in Philadelphia in the Land Title Building, in charge of Mr. W. A. Wood. The Philadelphia offices of the Bullock Company have, of course, been consolidated with the new offices of the Allis-Chalmers Company.

THE BURT MANUFACTURING COMPANY, Akron, Ohio, recently made a shipment of 21 Cross oil filters to Havana, Cuba. The company has worked up an extensive trade in foreign countries, recent shipments including nine filters and six exhaust heads to Sidney, Australia; eighteen oil filters to St. Petersburg, Russia; three to Calcutta, India, and four to Spain.

STANLEY ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., recently secured from the California Gas & Electric Corporation, of San Francisco, an order for two frequency changers of 5000 kilowatts capacity each, for use in connection with the railway work of the Corporation. The contract includes also transformers aggregating 12,000 kilowatts capacity.

THE HOLTZER-CABOT ELECTRIC COMPANY, Boston, Mass., is the subject of an interesting sketch in a recent number of *The Chronicle*, a Brookline, (Mass.) weekly publication. A brief history of the company is given, together with personal sketches of its officials and some interesting information as to the business policy and routine of the establishment.

GARTON-DANIELS COMPANY, Keokuk, Ia., advises us that each year a demand for a higher class of materials is noted, this being particularly true in the lightning arrester field. During the present winter the company has made up the largest stock of lightning arresters that it has ever prepared before, feeling confident of a decided increase of business activity during the coming year.

THE BRUCE-MERIAM-ABBOTT COMPANY is the style of a new organization composed of the Meriam-Abbott Company and The Bruce Company, of Cleveland, Ohio, who recently joined forces. The new company will continue the manufacture of the vertical twin-cylinder gas engiens and electric lighting plants formerly built by the Meriam-Abbott Company and the Bruce-Collins automatic engines formerly built by The Bruce Company.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY reports a brisk demand for its electrical apparatus. Among recent contracts were one for two 1000-kw. turbine-generator outfits for the Haverhill (Mass.) Electric Company, one for two 1500-kw. outfits for the Rochester, Syracuse & Eastern Railroad, and one for a 1000-kw. set for the Springfield (Mass.) Electric Light Company. The Westinghouse Company has also closed a contract with the Ontario Power Company for a 10,000-h.p. alternating-current generator; this is in addition to contracts for three similar machines previously closed. The generators are of the revolving-field type designed for direct connection to water-wheels.

CENTRAL STATION NEWS

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

ALABAMA.

DOTHAN.—Plans are being formulated for rather extensive improvements to the city electric light plant. These include the installation of a 250-kw. revolving-field alternator and a 375-h.p. engine. The lighting circuits will be changed from direct to alternating current and fifty series enclosed arc lamps will probably be put in, which will increase the number now in use by twenty-three.

DADEVILLE.—The Tallapoosa Water Power & Electric Company has been organized to develop 8000 horse-power on the Tallapoosa River in the vicinity of Sturdevant. The power will be used for manufacturing purposes. The company is capitalized at $500,000, and Mrs. R. T. Parker, of this city, is reported to be one of the incorporators.

TALLADEGA.—The plant of the Talladega Electric Power Company is being greatly improved and the line for transmitting the current to this city has been completed.

UNIONTOWN.—The City of Uniontown, W. J. Vaiden, Mayor, is arranging to remodel the city light and water plant. S. T. Townsend, superintendent of the plant, writes that they are in the market for a complete alternating-current system, including 100-kw. generators, transformers, switchboard and instruments, regulators for arc lighting, and all necessary apparatus for a 25-light system; a 150-h.p. engine will also be required to drive the generator. The plant is to be removed from its present location to a point near the railway tracks.

ARKANSAS.

CAMDEN.—A company composed of Little Rock, Camden and St. Louis business men has purchased the electric light plant heretofore operated by the Camden Power & Light Company. J. A. Trawick, president of the Little Rock Railway & Electric Company, is president of the new concern and J. A. Van Etten, of this city, is secretary. Others interested in the enterprise are George D. Rosenthal and William Hand, of St. Louis, and W. K. Ramsey, of Camden, who was treasurer of the old company.

MAGNOLIA.—Advices received from the Magnolia Ice & Light Company state that another 40-kw. 250-volt direct-current generator has been installed recently. When the improvements are completed the company's system will comprise convertible two and three-wire circuits operated at 220 and 440 volts, and the equipment will consist of three engines, two automatic engines running at 300 r.p.m. and one Corliss engine.

ENGLAND.—It is understood that the Council is considering the establishment of a municipal lighting plant.

CALIFORNIA.

COLTON.—There is reported to be a movement here towards establishing a municipal electric light and power plant.

CALISTOGA.—G. S. Cutler, of this city, has been granted a franchise to construct and operate an electric light system here.

SAN FRANCISCO.—The Consolidated Heat, Light & Power Company has been incorporated with a capital of $300,000, by William Thomas, Mark L. Gerstle, Robert N. Frick and others.

COALINGA.—The Board of Supervisors at Fresno has granted to F. W. Bray a franchise to construct an electric light plant, a natural or artificial gas plant and a water works system in this city.

ALAMEDA.—The contract for the new machinery, which is to be installed in the municipal lighting plant, has been let to Charles C. Moore & Co., of San Francisco. The contract is for $12,607 and includes an engine and generator.

REDDING.—The North Mountain Power Company's plant in Junction City is now completed and ready to furnish power to Eureka and adjoining towns.

VISALIA.—The Mt. Whitney Power Company is erecting a sub-station at Dinuba and now has in course of construction about twenty miles of high-tension transmission line and twenty miles of distributing lines.

UKIAH.—The present capacity of the municipal lighting plant has become inadequate to meet the requirements, but it has not been decided yet whether to enlarge the plant or to purchase additional power from some outside source.

NEWMAN.—The Newman Light & Power Company has been incorporated to manufacture and sell electric light and power. The company is capitalized at $20,000, and numbers among its directors Mrs. Annie McDonald, of San Francisco; Joseph McDonald, of Nappa City, and John G. McDonald, of this city.

LOS ANGELES.—The Edison Electric Company has placed contracts for generators and impulse wheels for its 25,000-kw. station under construction on the Kern River. Steel towers 75 feet high will be used on the 120-mile transmission line to this city.

EUREKA.—The loss on the plant of the Eureka Lighting Company, which was destroyed by fire recently, is estimated at $30,000, a little more than half of it being covered by insurance. Five dynamos, together with other machinery, were destroyed.

INDIO.—The Indio Light, Water & Ice Company has filed articles of incorporation, with a capital stock of $30,000. The directors are W. F. Everett, H. Kuhl, H. E. Tallant and J. S. Hunter, all of this city. Mr. Everett, the secretary, writes that it is proposed to construct water works, an electric light plant and a 10-ton refrigerating and ice plant.

ARCATA.—Brousse Prizard, president of the Arcata Light & Power Company states that it is proposed to purchase at once complete equipment for a transformer station, including three 100-kw. transformers, one 10,000-volt oil switch, and 80 assorted sizes of meters from 5 to 10 amperes.

SAN DIEGO.—Articles of incorporation have been filed for the United Light, Fuel & Power Company, capitalized at $500,000. The majority of the stock, it is said, is owned by John D. Spreckels, of San Francisco. The corporation proposes to construct and operate plants for the generation and distribution of electricity and gas for lighting, fuel and power purposes in this State. There are five directors.

HOLTVILLE.—F. C. Bayless, formerly of Redlands, is now superintendent of the Holton Town Company and the Holton Power Company, of this city. He writes that the Holton Power Company is erecting a large plant on the desert, near this place. A power canal has been constructed, 150 feet wide on the bottom with levies 50 feet thick at the base and 11.1 feet high at the lower end. A 52-inch pipe line extends from the end of the canal to the power house 1500 feet below.

SAN JOSE.—J. J. Inman, M. E. Page, W. H. Baugh, and others have filed articles of incorporation for the National Park Electric Power Company, with a capital stock of $250,000.

SAN FRANCISCO.—The Culiacan Electric Company has been incorporated by Sidney Sprout, Isidor Gutte, F. G. Brane and others. The company has a capital of $300,000.

SAN DIEGO.—The San Diego Gas & Electric Company has installed in its plant in this city a vertical McIntosh & Seymour engine rated at 450 horse-power and direct-connected to a 220-kw. three-phase generator. The cost of the new machinery is estimated at $30,000.

ESCANDIDO.—The land owners of the Escondido Irrigation District now own the entire water system. A company has been organized to take over the system and other assets and will soon commence extensive improvements to the plant. Among these improvements will be the erection of a 400-h.p. water power plant, the power to be transmitted to this city by electricity for lighting and power purposes.

COLORADO.

PAONIA.—James Beezley is reported to have sold out his electric lighting business, but the details of the transaction have not been made public yet.

GLENWOOD SPRINGS.—Work will soon be commenced on the power plant of the Colorado Irrigation & Power Company in the Canyon of the Grand River above this place. L. W. Beard is chief engineer and J. R. De Remeer is local representative of the company.

SALIDA.—The Edison Electric Company has practically completed its plans for the erection of a power plant at Arborville on the south fork of the Arkansas River, fifteen miles north of Salida. Ten carloads of machinery, consisting of turbine wheels and piping, have been ordered. The enterprise will involve the expenditure of $75,000 and is backed by local capital. The plan is to furnish cheap electric power to Salida.

CONNECTICUT.

ROCKVILLE.—Mayor Foster in his annual message has recommended municipal ownership of the electric light plant.

GAYLORDSVILLE.—The New Milford Power Company states that it contemplates the erection of several new plants in the near future, all on the Housatonic River.

HARTFORD.—Part of the new plant of the Hartford Electric Light Company at Dutch Point has been put into service, about 600 horse-power being supplied to the city by the company .

DANBURY.—The Danbury Power Company is said to be preparing plans for the establishment of dams and power stations on the Rocky River at New Milford and the Still River at Lanesville and Brookfield.

NORWALK.—The Connecticut Railway & Lighting Company advertises its intention of applying to the next Legislature for an extension of some of its charter rights and those of its constituent companies which expire July 1, 1905.

HARTFORD.—The Berkshire Power Company has awarded the contract for the initial electrical equipment to go in its water power plant to the Westinghouse Electric & Manufacturing Company. The contract calls for two units of 300 kilowatts capacity each.

NORWICH.—R. L. Warner, the New England manager of the Westinghouse Electric Company, is reported to have secured rights along the Quinebaug and Shetucket Rivers and proposes to construct a power plant in this section. The idea is to get a charter from the Legislature and sell power in this section of the State.

NORWICH.—A petition is to be presented to the general assembly at its next session by G. O. Jackson, E. W. Higgins and C. W. Comstock for the right, under the name of the Uncas Power Company, to manufacture, generate, transmit, deliver and sell electricity for any and all purposes in the towns of the county, with the exception of Norwich and New London, and for the right to distribute and sell electricity in Norwich and New London to the amount of not less than twenty-five horse-power per customer. The plant is to be located in Norwich.

CUBA.

MANZANILLO.—The electric light plant here is being overhauled by Mr. A. M. del Valle. The new plant is operated on the three-wire system with 250 volts on each side of the neutral, the generators being direct-current machines. The steam plant comprises Babcock & Wilcox boilers and compound condensing engines built by the Brush Electric Engineering Company, London. The fuel is anthracite coal dust, which is obtained without cost from ships carrying it as ballast; the coal dust is put through a process which makes it somewhat similar to soft coal. The municipal lighting is done by means of fifty arc lamps and 700 series incandescent lamps. The private lighting is almost entirely constant-potential incandescent lamps. Mr. del Valle desires catalogues from manufacturers of hydraulic and electrical apparatus, as the company will erect a new power house in the immediate future, in which the machinery will be driven by water power.

DELAWARE.

WILMINGTON.—The City Council will ask the Legislature for permission to borrow $200,000 for the construction of a municipal electric light plant.

DISTRICT OF COLUMBIA.

WASHINGTON.—The Red Cloud Electric Light & Mining Company has filed articles of incorporation, showing a capital stock of $300,000. George H. Corey, Eugene Schooley and J. L. Cohencious are the incorporators.

WASHINGTON.—Speaker Cannon is stated to have received from Bernard H. Green, Superintendent of the Congressional Library, a report recommending the construction of a central power station to supply all the uptown Government departments in the vicinity of the White House with light, heat and power. The report was made on a request by Congress last April. The plan provides for the removal of all boilers and engines from the departments in question, and the establishing of a single distributing point, with a system of conduits for the transmission of steam and electricity to the various scattered buildings. The estimated cost of the plant is $2,000,000, and it will cost about $200,000 a year to operate it.

FLORIDA.

OCALA.—The municipal electric light plant is being enlarged and the system changed over to alternating current.

TALLAHASSEE.—The equipment of the municipal electric light plant here has been increased recently by the addition of another unit.

GEORGIA.

DAWSON.—A new 150-h.p. boiler has been added recently to the municipal electric light plant equipment.

JONESBORO.—The city authorities are considering duplicating the electric plant here some time in the near future.

DECATUR.—The Decatur Electric Light, Power & Water Company recently added a 35-kw. dynamo to its plant equipment.

LITHONIA.—The new electric plant of the Panola Company, whose power house is about six miles from Lithonia, has been placed in operation.

SAVANNAH.—Local press reports state that the question of establishing a municipal electric light plant on the city lot is under consideration.

DOUGLAS.—The Savannah Electric Light & Power Company, of Savannah, has secured the contract for constructing an electric light plant here to cost $6250.

SAVANNAH.—Local reports state that the Savannah Lumber Company will install an electric light plant at its mill and supply power to private residences of the city.

FORT VALLEY.—Mayor J. L. Fincher writes that it is proposed to construct an electric light plant to cost about $6000, the contracts for which will probably be let in April.

CRAWFORD.—It has been decided at an election held by the citizens of this place to light the town by electric lights. The contract has been closed for the erection of arc lights at an early date.

McRAE.—Plans are being considered for extending the service of the municipal lighting plant to Helena, Ga. If this is done, four arc lights and 200 16-c.p. incandescent lights will be installed in that town.

GREENSBORO.—The Council has closed a contract with the Southern Electric Supply Company, of Athens, for the construction of the electric light plant here, at a cost of about $10,000. By the terms of the contract, the lights are to be turned on not later than April 1, the contractor forfeiting $10 per day for every day after that date that the plant is not completed.

COVINGTON.—On the morning of December 27 the city electric light plant here was completely destroyed by the explosion of a boiler, the engineer of the plant being instantly killed. The force of the explosion was so great as to hurl the 80-h.p. boilers a distance of several hundred yards and scatter fragments of the building over two or three acres of ground. The loss is estimated at $12,000 with no insurance. Although temporary arrangements have been completed by which the city is again to have electric lights, it is probable that as soon as other plans can be devised the city will discontinue its lighting system. Owing to the fact that the plant has not been self-sustaining since its establishment four years ago, the annual expenditures being from $1800 to $2000 greater than the receipts, a strong sentiment has developed in opposition to city ownership. Before an entirely new plant can be installed, adequate to supply the city's demands, there will in all probability have to be another bond issue, which, it is feared, would be voted down when submitted to the people. To obviate this possibility, there is a rumor that a private corporation, composed of Covington capitalists, interested in the development of an immense water power in the southern part of Newton County, will offer to buy the electric light franchise from the city and inaugurate a system with an increased capacity that would be in keeping with the growth of the town. This water power, known as White's Shoals, on Alcovey River, ten miles from Covington, is said to be one of the largest water falls in middle Georgia, and if properly harnessed its power would be sufficient to operate all the machinery, as well as light a number of towns, within a radius of 10 or 15 miles, which would include Monticello, Jackson, Flovilla, Covington, Oxford, Mansfield and Newborn.

IDAHO.

GRANGEVILLE.—The Grangeville Electric Light & Power Company is running a line to Cottonwood by way of Denver, a distance of fifteen miles.

WALLACE.—Electric power from Spokane will operate the Mammoth mill. A branch line has been brought down the canyon from the point where the line to the Morning mine leaves the main line, a 150-h.p. motor has been installed, and the necessary changes are all but completed for the electric operation of this large concentrator by electric power transmitted nearly 100 miles.

POST FALLS.—The contracts for the electric and hydraulic machinery in the new plant to be

built by the Washington Water Power Company, of Spokane, Wash., at this point have been awarded. The electrical work is to be done by the General Electric Company. The main work will be commenced some time this month. The cost of machinery, warehouses and mills will be about $500,000. The initial installation will be about 9000 horse-power, with an ultimate capacity of 18,000 horse-power.

ILLINOIS.

TOLEDO.—It is intended to install larger machinery in the city electric light plant.

LENA.—Benfer Brothers, of Winslow, have petitioned for a franchise for a lighting plant.

ROCKFORD.—Reports state that J. C. Yeager has sold his electric light plant to Mr. Burdick, of Chicago.

EAST MOLINE.—F. C. Dunbar is said to be interested in the construction of an electric light plant here.

LA HARPE.—The La Harpe Electric Light & Power Company has recently installed a storage battery in its plant.

LAMOILLE.—Reports state that private parties are negotiating for the installation of an electric lighting system for the town.

CHICAGO.—A franchise has been granted to the Garts-Arnold Electric Company for the lighting of North Avenue, this city.

ONEIDA.—At the request of H. W. Crane, the City Council has granted a new franchise to the Oneida Light & Power Company.

COLLINSVILLE.—The Collinsville Electric Light, Heat & Power Company has recently installed a new 250-h.p. engine in its plant.

GIFFORD.—An electric light company has been organized by the citizens for establishing an electric light plant, which will be erected during the coming summer.

QUINCY.—The controlling interest in the Independent Light & Power Company, of this city, has been sold to a Chicago capitalist. The new manager will be N. J. Ferris, of Chicago.

DIXON.—The Lee County Lighting Company, of which John I. Beggs, of Milwaukee, is president, has purchased the plants and property of the Dixon Power & Lighting Company, of this city.

CHICAGO.—The Georgetown Electric Company has been organized with a capital of $15,000 to operate a heat, light and power plant. The incorporators are W. F. Brugman, A. M. Searle and C. C. Travis.

RED BUD.—J. A. Hamilton and A. B. Daah are among the organizers of the Red Bud Light & Power Company, which was recently incorporated with a capital of $20,000 to operate a lighting, heat and power plant.

PALMYRA.—The Waverly Telephone Company, which has the city contract for electric lights, states that if its business continues to grow as it has in the past it will be necessary to install another dynamo and engine in the near future.

CHILLICOTHE.—J. S. Daily, the enterprising proprietor of the Chillicothe Electric Light & Water Works, sends out a very dainty little calendar, which should serve to keep the recipients in mind of the giver throughout the year.

LINCOLN.—Of the $750,000 worth of bonds authorized by the Springfield & Northwestern Railway Company for the completion of its interurban line, it is reported that $150,000 will be devoted to the construction of a central power plant in this city.

EDWARDSVILLE.—The power plant of the Edwardsville Electric Light & Power Company has been purchased by the syndicate in control of the Illinois Traction Company's interurban road. New machinery will be installed, it is said, and the plant refitted throughout.

CHICAGO.—Bids will be received February 15 by S. D. Griffin, Clerk of the Board of Trustees Sanitary District, of Chicago, for furnishing and installing alternating-current generators and generators for exciters, the said generators to consist of four 4000-kw., 6600-volt three-phase 60-cycle generators, 164 r.p.m., and two 350-kw. 250-volt direct-current generators, 300 r.p.m.

CHICAGO.—In a recent issue of the Brooklyn (N. Y.) *Eagle*, Mayor Carter Harrison gives an interesting history of municipal lighting in Chicago up to 1904. He furnishes tables of statistics showing the comparative cost of maintenance per year since 1897 and the extensive improvements made in the meantime; also tables of the itemized cost of maintaining a single arc lamp, which are valuable in determining when economy has been or can be secured and in accounting for excessive expenditures. Mayor Harrison feels that the people of Chicago have received better service and cheaper rates on account of the municipal electric lighting system than would have been possible had the system been operated by private parties.

INDIANA.

LOOGOOTEE.—E. H. De Wolf has petitioned the Council for an electric light franchise.

CLAYTON.—Steps are being taken toward establishing an electric light plant in this city.

GREENFIELD.—It is proposed to increase the engine and boiler capacity of the electric light plant.

RIVERSIDE.—The Muncie Electric Light Company, of Muncie, has secured the contract for lighting Riverside for a term of five years at $50 per light per year.

BRAZIL.—The Brazil Electric Company is reported to have purchased property on Main Street as a site for a new power house which is to be erected in the early spring.

MARION.—It is reported that the power plant owned by the Pittsburg-Columbia Oil Company, which was recently destroyed by fire, will be rebuilt to be used for the generation of electricity.

ORLEANS.—Heise Bros. & Co. have been granted a franchise to construct and maintain an electric light plant in this town. They propose to begin work at once and have the plant in operation by April 1.

SHELBURN.—William Whaley and Noland B. Stadley, of Terre Haute, are reported to have secured a twenty-year franchise for city and commercial lighting in Shelburn. The plant will be located between Shelburn and Hymera.

ZIONSVILLE.—An electric light plant is to be installed in this town, for which the Indianapolis & Northwestern Traction Company will furnish the power. A sufficient number of arc lamps will be purchased to light the town thoroughly.

COLUMBUS.—It is stated that bids will be received February 2 by the Common Council for two 150-h.p. boilers designed for 150 pounds working pressure, and all necessary foundation work, brick settings, steam piping, smoke stacks, etc.

INDIANAPOLIS.—The Indianapolis Light & Power Company and the Marion County Hot Water Heating Company have been merged into a single corporation to be known as the Indianapolis Light & Heat Company. The company will manufacture and sell electricity for light and power and will furnish hot water heat in the city of Indianapolis. The capital stock of the new company will be $1,000,000.

INDIAN TERRITORY.

CADDO.—The Choctaw Cotton & Power Company has been succeeded in business here by the Caddo Light & Power Company.

CHICKASHA.—Mr. Ross, formerly of the Ross Electric Company, of Lincoln, Neb., has sold out his business in that city and will move to Chickasha, where he will assume the management of the Chickasha Light & Power Company.

MUSCOGEE.—The Commercial Club has taken up a project for making use of the falls on Grand River ten miles from this city, to generate power for transmission to the town. Engineers have been employed to locate the best site for a power house and as soon as the plans can be completed the Commercial Club will undertake to finance the deal.

IOWA.

WAVERLY.—The Healey Electric Light Company has sold out its business.

COLUMBUS JUNCTION.—The Council has under consideration the matter of constructing an electric light plant.

GUTTENBERG.—The Guttenberg Electric Light Company contemplates establishing a power circuit for day service.

OSCEOLA.—The electric light plant here is to be enlarged and a day circuit for power purposes will be added. A hot water plant is also to be installed.

BURLINGTON.—Plans are on foot for the organization of a stock company for the purpose of putting in an electric light plant at West Burlington.

CHARLES CITY.—The Charles City Light & Heat Company is considering changing its lighting circuits from the open arc to the series enclosed arc system.

OTTUMWA.—The Ottumwa Traction & Light Company is having plans prepared for a new power house to be built in the spring at an approximate cost of $25,000.

MARSHALLTOWN.—City Clerk L. Derby writes that it is proposed to increase the number of city arc lights from 130 to 200. The expense of installing the new lights is estimated at about $8000.

CHARITON.—The city electric light plant will be rebuilt at a cost of about $40,000. New machinery has been purchased and it is expected to have the system in operation by spring. The entire system will be remodeled, many of the main wires having been either totally destroyed or badly damaged by the big fires last winter and spring.

WATERLOO.—The Waterloo & Cedar Falls Gas & Electric Light Company has been incorporated with a capital of $595,000, with headquarters in this city. The company will engage in a general gas and electric business, but was incorporated with the principal object of erecting a gas plant at Cedar Falls, where a franchise was recently granted. The directors are J. H. Leavitt, G. E. Lichty, George McLean, and others.

KANSAS.

TOPEKA.—The advisability of changing from direct to alternating-current series enclosed-arc lights is being considered.

STERLING.—A gas engine and an additional dynamo are to be installed in the electric light plant for the purpose of operating a day circuit.

BRONSON.—The Bronson Light & Telephone Company has secured a franchise to operate lighting and telephone systems in this city and is said to be ready for business.

ANTHONY.—W. A. Miller, chairman of the committee on arrangements for the establishment of an electric light plant for the city, writes that he would like to correspond with parties interested in such a project.

HAYS CITY.—Justus Bissing, proprietor of the Hays City Electric Light Plant, is arranging to operate his lighting circuits from dusk till morning every night instead of on a moonlight schedule and only until 12:30 p. m. He also expects to install a condenser in the early spring.

KENTUCKY.

MAYFIELD.—The Mayfield Water & Light Company recently intalled a 300-kw., direct-connected, 60-cycle, two-phase alternator in its lighting plant.

LOUISIANA.

LAKE CHARLES.—The City Council is reported to be considering the establishment of an electric light plant.

DONALDSONVILLE.—New poles and overhead lines are being erected in connection with the city lighting plant, besides some other minor improvements.

MARKSVILLE.—Arrangements are being made for the purchase of the private electric lighting plant here by the city, in connection with which a water works system will be installed. Plans and specifications for the latter are in preparation.

MAINE.

KENNEBUNK.—The Kennebunk Electric Light Company will probably add another unit to its equipment the early part of this year.

BANGOR.—The Council is said to be considering the advisability of increasing the capacity of

the city lighting plant. M. H. Rideout is superintendent of the plant.

PORTLAND.—The National Heat, Light & Power Company, of this city, has been incorporated with a capital of $5,000,000. M. W. Baldwin is president and J. J. Herman is treasurer.

PORTLAND.—The Northwestern Power Company has filed articles of incorporation, stating its capital stock to be $10,000,000. J. C. Rice, of Boston, is president, and C. N. Drummond, of this city, treasurer.

PITTSFIELD.—The Sebasticook Power Company has started up its machinery for business, and has begun furnishing electricity to light the homes, offices, stores and streets of Pittsfield. The electrical machinery includes three 300-kw., three-phase generators and one 100-kw. machine of the same kind. There will also be two 25-kw., moderate-speed exciters of 125 volts, either machine being capable of exciting all three of the generators. As soon as all is in complete working working order, the company will furnish power and light to various industries.

MARYLAND.

SNOWHILL.—The capacity of the Snowhill Electric Light & Power Company's plant has recently been increased to 1800 lights and two direct-current generators have been added.

BALTIMORE.—The United Electric Light & Power Company has purchased a majority of the stock of the Consolidated Gas Company. This is the beginning of the consummation of plans contemplating the consolidation of the United Electric Light & Power Company and the Gas Company.

ELLICOTT CITY.—Plans are being formulated by the Patapsco Electric Light & Power Company for the establishment of a power house on the Patapsco river, below this city. It is claimed that in view of the excellent water power afforded by the river at the point selected the operations can be made very profitable.

BALTIMORE.—Mr. W. J. McManigal, an electrical expert, has been appointed general manager of the new electric light and power department of the Maryland Telephone and Telegraph Company. He is a native of New York and about 50 years old. He has spent most of his business life in the West and has had about 15 years' experience in the operation of electric light and power plants. Mr. McManigal was general manager of the big plant at Omaha, Neb., and superintended the construction of the $6,000,000 plant that is being built at St. Louis when he accepted the position with the Maryland Telephone Company. He is married and will move his family from St. Louis to Baltimore. H. W. Webb, vice-president of the Maryland Telephone Company, states that work is progressing very satisfactorily on the construction of the new electric light and power plant along the water front in South Baltimore, and that it will be rushed as fast as possible, with the hope of having the establishment ready for operation about July 1, 1905.

MASSACHUSETTS.

CHELSEA.—W. M. McDonald and others have petitioned for a public hearing upon the proposition to purchase a municipal lighting plant.

MELROSE.—Mayor Buttrick, in his annual message, is reported to have recommended that steps be taken to establish a municipal lighting plant.

FAIRHAVEN.—The Mansfield municipal electric lighting plant is now supplying power to the Bay State Tap & Die Company, of this city, for the operation of its plant.

MANSFIELD.—It was voted at a recent town meeting to appropriate $1900 for an increase in the commercial department of the electric lighting system and to light the town hall and library by electricity.

BOSTON.—The Common Council and the Board of Aldermen have passed an order authorizing the city to construct or lease and maintain one or more plants for the manufacture and distribution of gas and electricity.

SPRINGFIELD.—The Springfield Electric Light Company has closed a contract with the Westinghouse Electric & Manufacturing Company for a 1000-kw. outfit with exciter. The contract also includes two 500-kw. rotary converters and four 300-kw. transformers.

HOLYOKE.—The contracts for the new machinery for the municipal electric plant have been let. The General Electric Company is to furnish a 500-kw. generator and a steam turbine to operate the same. The contract for three 250-h.p. Manning steam boilers was awarded to Coghlan's Holyoke steam boiler works for $6600. It is expected that the new apparatus will be in running order about May 1.

PALMER.—The annual meeting of the Central Massachusetts Electric Company was recently held in this city and the following officers elected: President, C. E. Fish; vice-president, G. C. Flint; manager, A. J. Purinton; treasurer, C. B. Fiske; clerk, A. J. Purinton. The officers and the following-named gentlemen comprise the board of directors: G. E. Fuller, of Monson; Edward Fairbanks and W. H. Fairbanks, of Warren; A. W. Paige and C. F. Grannis, of Bridgeport, Conn.

HAVERHILL.—The controlling interest in the Haverhill Electric Company, much of the stock of which is held in New Haven, Conn., has been acquired by the same interests that control several gas and electric companies in Massachusetts, including the Springfield Gaslight, the Malden Electric and the Suburban Gas and Electric companies of Revere and Winthrop, Mass. The Haverhill company is capitalized at $150,000 and is a growing and prosperous concern. It pays an annual dividend of 8 per cent. The directors of the Springfield Gas-light Company, who now control the Haverhill and other companies, are C. H. Terney, of Hartford; F. P. Royce, Oakes Ames and H. P. Ward, of Boston, Mass.; P. F. Thompson, of New York; Herbert C. Warren, Edwin Bradley and Samuel A. York, of New Haven. The Haverhill company is to be operated as heretofore, and it is stated that no consolidation of plants is planned.

CHICOPEE.—The annual report of the electric light department of Chicopee was filed yesterday with the City Clerk, and has some interesting features. The electric light department shows that the plant and equipments have increased in value $66,420 since it was first operated. The manufacturing and distributing cost have increased yearly, mainly for the reason that the plant has been called upon to do more work each year. The increase in this cost for the past year over that of the previous year was $802. The income from incandescent lights sold for commercial and domestic purposes has been on the increase, last year's margin being $1562. There has been a steady increase in the income from incandescent lights furnished city buildings and other city property, but the past year shows a decrease of $177 from that of 1903, which is due to the fact that the West Springfield bridge is out of existence. The income from city arc lights shows an increase yearly, with $653 for this year's net over last year. There are 188 street arc lights. The net income over manufacturing expenses of all classes of light furnished for this year was $7169, but the fixed charges of bonds and interest to be set off against this is $7587, or a net bookkeeping loss of $418. On October 10 the plant began to work 24 hours a day, and now furnishes power as well as light.

MICHIGAN.

SAUGATUCK.—A franchise has been granted to Charles Floyd and B. Van Raalte, Jr., to construct and operate an electric light and power plant.

ANN ARBOR.—City Clerk Granger writes, in regard to the lighting of the city streets, that plans are now being prepared but no definite action has yet been taken.

PERRY.—The Standard Heating & Lighting Company, of Detroit, has secured from the Village Council a contract to light the streets of this village and will soon begin the erection of a plant.

DETROIT.—Frank R. Mistersky, chief electrician of the municipal lighting plant, has been promoted to the position of assistant superintendent to succeed A. S. Hatch who has resigned. Mr. Mistersky will be succeeded by W. A. Andrews.

ST. LOUIS.—Burton E. Lucas, superintendent of the city light, plant, has resigned that position to assume the management of the Harbor Springs (Mich.) electric light plant. Previous to his connection with the St. Louis plant, Mr. Lucas was superintendent of the Ovid electric light and water works.

KALAMAZOO.—The Kalamazoo Valley Electric Company has been reorganized as the Commonwealth Power Company with a capital of $4,000,000. It is the intention of the company to increase the capacity of its plant sufficiently to enable it to furnish power for electric roads which will be built between this city and Grand Rapids in the near future. William A. Foote is president of the new company, and C. H. Frisbie, vice-president, both of Jackson.

NORTHVILLE.—The Common Council is stated to have granted a franchise to C. A. Ward, of Ann Arbor, for furnishing electricity for lighting the streets and residences and power for factories in the town. The franchise is for 30 years and carries with it a 10-year contract to supply the village and private consumers. The company will develop its electricity near Hamburg, on the Huron River, where it will build three dams. Generators will be placed at each dam, and the electricity transmitted to Northville, South Lyon, Ypsilanti, Ann Arbor and other points.

GRAND RAPIDS.—Articles of association have been filed by the Grand Rapids-Muskegon Water Power Electric Company, with a capital of $1,000,000, to build one or more dams on Muskegon River, to convert water power into electrical current and to deliver this for commercial purposes in Grand Rapids, Muskegon, Big Rapids and other places. The first dam will be built at Rogers' Bridge, about 6 miles below Big Rapids. The directors are: Thomas Huma and David D. Erwin, of Muskegon; W. A. Foote, of Jackson; John E. Moro, of Grand Rapids, and others.

ALPENA.—A deal is reported to have been closed by which Frank W. Fletcher, George P. Smith and other capitalists secure control of the Alpena Electric Light Company, the Alpena Water Company and the Thunder Bay Boom Company. These companies will be merged into a new company, to be known as the Alpena Power Company, with a capital of $500,000. The new company controls all the water privileges of Thunder Bay River, and is organized for the purpose of supplying electric power to Alpena manufacturers, as well as continuing the business of the old companies. Hubbard Lake will be raised 6 ft., thus largely increasing the water power of the river.

MINNESOTA.

EAGLE LAKE.—The City Council has under consideration the question of constructing either a gas or an electric light plant.

BECKEE.—Reports state that an electric light plant is to be established here, but none of the details of the project have been given out.

DULUTH.—The Great Northern Power Company is now prepared to develop the large water power of the St. Louis River. The National Railway Contracting Company, of Boston, has been awarded the contract for the development work, including the construction of the power canal. The enterprise is being financed by Tucker, Anthony & Co., of Boston, and Charles D. Barney & Co., of New York and Philadelphia. The company is capitalized at $8,000,000. C. A. Duncan is president of the company, and Francis A. Cokefair, chief engineer. The power plans call for an initial development of 30,000 horse-power, which will later be increased to possibly 200,000 horse-power. Five hundred men will be employed upon the work, which is to begin this winter. The Duluth-Superior Traction Company is said to have contracted already for a maximum of 10,000 horse-power to operate its system.

MISSISSIPPI.

YAZOO CITY.—The Yazoo City new electric lighting plant was put in operation recently.

McCOMB.—The McComb City Electric Light & Power Company has been incorporated with a capital of $50,000.

ABERDEEN.—Bonds to the amount of $80,000 have been authorized by the City Council for the construction of an electric light plant and a system of water works and sewers.

MISSOURI.

POPLAR BLUFF.—Reports state that Bacon, Hays & Wilkey have purchased the business of the Hartzell Light & Milling Company.

TRENTON.—Part of the plant of the Trenton Gas, Light & Power Company has been destroyed by fire, but the damage to the machinery is said to have been slight.

VERSAILLES.—The City Council has accepted the electric light plant from the St. Louis contractors. The plant is owned and operated by the city and was built with the proceeds from the sale of $10,000 in bonds.

MARCELINE.—Early & Callahan, proprietors of the local electric light plant, are extending their lines to include the new portions of the city, which involves the stringing of several miles of wire and the erection of new poles.

STANBERRY.—The Stanberry Electric Light Company is making arrangements to operate a day circuit, beginning about April 1 of this year. The company is also contemplating putting in a steam plant. Another engine of the Corliss type, direct-connected to a 75-kw. generator, has been recently installed in the present plant.

STURGEON.—The Board of Aldermen has appointed a committee, consisting of W. S. Harris, J. W. Hulett, O. D. Gray and O. I. King, to visit various Missouri cities for the purpose of investigating the cost of installing and maintaining a muncipal electric light plant. Upon receipt of the committee's report, the advisability of bonding Sturgeon for a sufficient amount to install the plant will be considered.

ST. LOUIS.—Another reduction in the cost of lighting the city institutions by the municipal lighting plant is contained in the report of the chief engineer to the president of the Board of Public Improvements. The reduction becomes plain when it is considered that less than four years ago the city was paying 13½ and then 7½ cents per kilowatt-hour for light, and is now paying more than 5 per cent. for light to other city buildings. The engineer's report for the month of December states that the city is receiving the same light at the rate of 1.058 cents. In this way the engineer who devised the plant and installed it in the new City Hall has notified the Board of Public Improvements that the plant, which cost $35,000, will have paid for itself in less than a year out of the difference in the cost of light. The president is sanguine of the installation of the new central lighting and heating station to supply the House of Refuge, Poorhouse, Insane Asylum and Female Hospital on which site the new City Hospital is now being erected. Friends of municipal ownership are enthusiastic over the showing of the lighting plant.

MONTANA.

BOZEMAN.—The Gallatin Light, Power & Railway Company is expecting to either remodel its steam plant or install a large water power plant during the coming summer.

NEBRASKA.

GERING.—G. L. Shumway has organized a company, known as the Pathfinder Electric & Water Power Company, which purposes building an $85,000 power plant, with a capacity of 400 horse-power, on the North Platte River, near Gering. It will be necessary to construct a ditch four miles long to conduct the water to the proposed site.

NEVADA.

RENO.—The Washoe Power & Development Company's electric plant is rapidly nearing completion and the management expects to be furnishing power for electric lighting and other purposes within the next three or four months.

NEW HAMPSHIRE.

LACONIA.—Allen A. Tirrill, of Schenectady, N. Y., is said to be interested in the construction of an electric power station on Pemigawassett River, near Franklin, this State. The current will be transmitted to this city for lighting and power purposes. Mr. Tirrill is also reported to have secured an option on the local electric light plant.

NEW JERSEY.

ASBURY PARK.—The Council has granted a franchise to Jesse W. Starr for a gas and electric light plant.

BORDENTOWN.—The Bordentown Electric Light & Motor Company is changing its lighting system from direct to alternating current, both for public and private lighting.

HAMMONTON.—H. E. Woodman, C. E. Starr and F. P. Reed have filed articles of incorporation for the Hammonton Electric Light Company, fixing the capital stock at $50,000.

PERTH AMBOY.—Peter Floersch, Kelly & McAlinden, Sickles Brothers, and other merchants of this town, are said to be interested in the organization of a company to construct an electric light plant.

BAYONNE.—It seems likely that Bayonne will eventually erect and operate its own electric lighting plant. Mayor Brady favors the enterprise, and it is believed that the question will be seriously considered, as the present contract expires soon.

PITMAN GROVE.—The plant of the Pitman, Clayton & Glassboro Electric Light Company has been sold to M. K. Treichler, of Philadelphia, for $20,000. The plant is a valuable one, with franchises for lighting several towns in the vicinity.

KEARNY.—The Council has passed a resolution, after rejecting all bids for lighting the town, providing for the construction of a municipal electric light plant and authorizing the Lighting Committee to engage an engineer to prepare complete plans and specifications for such a plant.

JERSEY CITY.—The North Jersey Electric Heat, Light & Power Company, recently incorporated, has elected officers as follows: President, Thomas J. Malone; vice-president, Michael T. Connolly; secretary and treasurer, Christopher P. Smith. Other directors are William J. Dynan and Charles Wagner. It is understood that the organization is entirely independent of all other electric light companies, and it is proposed to begin operations in the spring in territory in which electric lighting is practically undeveloped.

NEW MEXICO.

GALLUP.—Reports state that George Page has succeeded to all the stock and business of the Gallup Electric Light & Power Company.

NEW YORK.

COHOES.—Plans are being prepared for increasing the capacity of the local lighting plant.

ONEIDA.—De Witt C. Hadcock, of this city, states in regard to the Limekiln Falls water power, that contracts will not be let until April 1.

ROCHESTER.—The Denio General Electric Company has been incorporated with a capital of $200,000. H. F. Atkinson and G. W. Ham are among the directors.

LOCKPORT.—The American District Steam Company has petitioned the Council for a franchise for the transmission of electricity for lighting, heating and power purposes.

FORT PLAIN.—The Fort Plain Gas & Electric Light, Heat & Power Company has secured the contract for lighting the town for five years more at the rate of $60 per light per year.

BATAVIA.—The incorporation of the Batavia Light & Power Company Company, with a capital of $10,000, is reported. Seth W. Warren and George R. Howard are among the incorporators.

CANAJOHARIE.—The Montgomery Electric Light & Power Company is considering the installation of an auxiliary steam plant with a capacity of 250 horse-power, as a reserve in case of an accident to the water plant.

PALMYRA.—William T. Morris, of Penn Yan, who recently purchased the gas plant at Lyons, has bought the electric light plant of this city, which was owned by O. J. Garlock, president of the Garlock Packing Company. It is said the plant cost $35,000 when it was installed.

NEW YORK CITY.—The Manhattan & Bronx Electric Company, with a capital of $10,000, has been incorporated for the manufacture of electricity to supply light, heat and power in the boroughs of Manhattan, Bronx, Brooklyn, Queens and Richmond. The directors are Willis B. Richards, John S. Clark and James C. Stratford.

OSWEGO.—The People's Gas & Electric Company has secured the contract for lighting the city for a term of five years at $66 per arc light per year and $3.65 per year for incandescent lights. As there are 261 arc lamps distributed about the city and 259 incandescent lights used in the public buildings, etc., the total amount covered by the contract is $18,171.35 per year for all-night service.

ALEXANDRIA BAY.—The St. Lawrence International Railroad & Land Company is steadily improving its water power development and expects soon to be prepared to furnish light to Redwood, a small town about seven miles distant. The company expresses itself as well pleased with the success of its railroad and lighting systems during the past year.

BROOKLYN.—The past year has been one of marked development for the Edison Electric Illuminating Company, of Brooklyn. There has been a large increase in the business of the company during the year, amounting to over 20 per cent. The company has spent about $2,000,000 in improvements in the last two years, and preparations are now being made at the Gold Street waterside station for the arrival and installation of a 10,000-h.p. turbine and generator having a capacity of 7500 kilowatts.

NEW YORK CITY.—The New York Edison Company has secured the contract to supply the entire service for the new Hippodrome which is being erected on Sixth Avenue, between Forty-third and Forty-fourth Streets. There will be 17,800 incandescent lamps and something more than 200 horse-power in motors. The facade is to be outlined in incandescent lamps, and large signs are to bring forcibly to the attention of the passing public the purpose of the building and the attraction for the time being presented. The New York Edison Company and the Edison Electric Illuminating Company of Brooklyn were the only bidders for the lighting of the Brooklyn Bridge. The contract was divided, one-half going to Manhattan and the other to Brooklyn. The bids were $130 a lamp a year for the 2000-c.p. arc lights and $18 for incandescent lights.

NEW YORK CITY.—The Board of Estimate has adopted a resolution appointing a commission to prepare general plans and specifications for, together with an estimate of the cost of, a municipal electric light plant for New York City. The commissioners will be Nelson P. Lewis, chief engineer of the Board; Prof. George C. Sever, of Columbia University, and Cary T. Hutchinson, consulting electrical engineer. The utilization of the city's waste for boiler purposes will be considered. Comptroller Edward M. Grout has been investigating the cost of gas and electric lighting as supplied to the city at present, in which work he was assisted by Mr. Edward B. Ellicott, city electrician of Chicago. Much objection to the proposition of establishing a city plant is being organized, and Lighting Commissioner Oakley maintains that the figures relating to the comparative cost of lighting in other cities refer to so many differing conditions that it is not fair to base any conclusions upon them.

NORTH CAROLINA.

ASHEBORO.—The Asheboro Electric Company has been incorporated by A. M. Rankin, W. M. C. Hammer, W. J. Miller and others. The company will construct and operate an electric light and power plant in Asheboro. It is capitalized at $50,000.

CHARLOTTE.—The Factory Site & Power Company, which was incorporated at Waynesville lately, with a capital of $300,000, is now transmitting 500 horse-power of electricity and will soon have 1500 horse-power more for the use of cotton mills and other factories in its neighborhood.

SOUTHERN PINES.—R. L. Chandler, proprietor of the R. L. Chandler Electric Light Plant, writes that he is in the market for a good new or second-hand engine suitable to run an electric light plant of about 80 or 100 horse-power capacity. He also expects to be in the market soon for an alternating-current generator.

ROCKINGHAM.—The water power at Bluett's Falls on the Pee Dee River, about eight miles from this place, is soon to be developed. Negotiations, which have been pending for more than a year, have culminated in the taking over of a number of options by Hugh McRae & Company, bankers, of Wilmington, involving the expenditure of about $120,000 for the rights on both sides of the river. It is thought that 30,000 horse-power can be developed, which will be distributed to points within a radius of twenty or thirty miles. The work will be commenced at an early date, either by McRae & Company or by a corporation organized by them for the purpose.

OHIO.

CAMDEN.—The Camden electric light plant has been sold to E. C. Eickenberry for $3000.

MIAMISBURG.—An issue of $19,000 bonds has been authorized by the village to be used for enlarging and improving the electric light plant.

WARREN.—The Phoenix Electric Company, with a capital of $5000, has been incorporated by W. A. Smith, Glen C. Webster, Edwin O. Izant and others.

MT. VERNON.—Mr. Hubbell and others have been granted a franchise for an electric light plant, which will be constructed and operated under the name of the Citizens' Electric Company.

DILLONVALE.—William B. Dager, Frank Alexander and others have filed articles of incorporation for the Dillonvale Heat, Light & Power Company, with a capital of $50,000.

TOLEDO.—The Toledo Heating & Light Company is contemplating extensions and improvements this coming spring, which will probably include the substitution of alternating for direct current in its lighting circuits.

CINCINNATI.—Local press reports state that the Cincinnati Gas & Electric Company will expend, in the near future, about $500,000 in the West End and about $200,000 in the East End in extending and improving its service.

CLEVELAND.—The Cleveland Electric Illuminating Company, in bidding for the work of furnishing arc street lamps to Cleveland for 1905, lowered its price $1.44 per lamp a year. At present the city is paying $75 per lamp a year for arc lights. The new bid of the company is $73.56 per lamp. Since Cleveland has 1211 lamps the lower price means a saving of $1,743.84 a year.

YOUNGSTOWN.—J. H. Perkins, general superintendent of the Youngstown Consolidated Gas & Electric Light Company, has resigned that position to become general manager of the Wilkesbarre Gas & Electric Company, Wilkesbarre, Pa. Alexander Webb, of New York, has been elected treasurer of the Youngstown Company to succeed Mr. L. C. Root, who resigned recently.

BARBERTON.—A new electric lighting plant may be installed in Barberton in a short time. The Barberton Inn owners, O. C. Barber, of Akron, and M. J. Alexander, of Pittsburg, hold a franchise granted them about a year ago by the Council which gives them the right to install an electric lighting plant and to wire the city. The plant of the Barberton Inn, which furnishes all the light for the big hostelry, is now being run at only an eighth of its capacity, and it could alone furnish electricity for lighting the downtown section of the town. The plan is to install a bigger plant at the Inn and to compete with the Northern Ohio Traction & Light Company.

OKLAHOMA TERRITORY.

SHAWNEE.—The Shawnee Light & Power Company is making extensions to its system in order to keep pace with the demands for service.

GUTHRIE.—The Guthrie Electric Light & Power Company, which was recently incorporated at $150,000, has increased its capital stock from that amount to $250,000.

OREGON.

COQUILLE.—Manager Frank Moore, of the Coquille Electric Company, will improve the present property by the installation of new boilers and the erection of a 25 x 100-ft. storage house.

THE DALLES.—The power plant of The Dalles Electric Light Company will soon undergo extensive improvements. Manager J. G. Van Orsdale states that a larger engine will be installed and new dynamos added.

FOREST GROVE.—The interests of E. W. Haines and others in the electric light plant of this place have been taken over by the Haines Electric Power Company. E. W. Haines, John Thornburg, C. W. Nottingham and J. Frank Watson are the incorporators. The company is capitalized at $50,000.

HOOD RIVER.—The board of directors of the Hood River Electric Light, Power & Water Company has authorized an issue of $100,000 in bonds which will be used in making extensive improvements in the service. H. F. Davidson has been elected president and general manager of the company, H. L. Vorse having resigned.

OREGON CITY.—The Portland General Electric Company, of which H. W. Goode is president, is preparing plans for the construction of a 40,000-h.p. electric plant at Willamette Falls, near this city. When the undertaking is carried into effect the company will have facilities for generating a total of 52,000 horse-power at the Oregon City plants and a duplicate steam plant in Portland. The new power station is to be built on the east side of the river and will be so constructed that any needed amount of power can be developed by adding units to meet the demands. The first installation at the new station will probably be three units, or 10,500 horse-power. Additional units of 3500 horse-power will be installed as rapidly as the demand for electric light and power develops. For every unit installed at the Oregon City plant a unit will be added to the steam plant in Portland. The building of a duplicate plant to be operated by steam is for the purpose of providing power to be used during the low water period each year and to avoid a possibility of having the service crippled by accident. The company intends to be in a position to furnish power and light not only to Portland but to any of the towns in the Willamette valley, and to meet the needs of the rapidly multiplying manufacturing industries in this territory.

PENNSYLVANIA.

STATE COLLEGE.—The Nitanny Light, Heat & Power Company has been incorporated with a capital of $10,000.

YOE.—The Yoe Electric Light Company has filed articles of incorporation stating its capital stock to be $5000.

CARBONDALE.—The Hendrick Light & Power Company has petitioned for a franchise for an electric light plant.

MAHANOY.—The Mahanoy City Light, Heat & Power Company has sold its entire plant to the Shenandoah Electric Illuminating Company.

YORK.—The Edison Electric Light Company is equipping an auxiliary plant for use at such times as high water and ice may impair the efficiency of the power plant at York Haven.

PITTSBURG.—The Committee on Public Works has recommended an ordinance authorizing the letting of the contract for lighting the city for one year at a cost not to exceed $400,000.

WEST CHESTER.—The Council has passed a resolution renewing the contract with the Edison Electric Illuminating Company for lighting the streets for the next five years at $10,000 per year.

TAMAQUA.—The Town Council has awarded to John F. McGinty and E. M. Sharp the contract for lighting the town for a period of ten years at $60 per light per year. They will commence constructing their plant in the spring and will be ready to take up their contract on January 1, 1906.

CHAMBERSBURG.—At a special meeting of the Borough Council, Burgess Sharpe submitted a message vetoing the ordinance authorizing the sale of the Chambersburg light plant to the Chambersburg Light, Heat & Power Company. The chief reason given for the veto is that the price is inadequate.

EASTON.—Bayard G. Eckard has been appointed superintendent of the Easton municipal electric light plant. Mr. Eckard is a graduate of Lafayette College, and at the time of his appointment was in the New York office of the Westinghouse Electric & Manufacturing Company.

PLYMOUTH.—This city has been selected as headquarters for the new light company which recently acquired control of the plants at Nanticoke, Plymouth, Edwardsville, Kingston, Luzerne, Dorranceton and Forty Fort. C. A. Geist and Charles B. Kelsey, who are at the head of the new combine, promise many improvements.

YORK HAVEN.—The York Haven Light & Power Company has procured a 60-day option on the plant of the Steelton Heat & Electric Light Company, which furnishes light and heat to the borough of Steelton and the adjoining town of Oberlin. If the deal for the Steelton plant is finally consummated, it is proposed to furnish its power from the York Haven plant.

PHILADELPHIA.—The Commonwealth Electric Company has been incorporated with a capital of $100,000, wih the expectation of supplying electricity for lighting, heating and power purposes. The incorporators are Mark Hyman, New York; Ross A. Mackey, Brooklyn; Herbert Scovill, New York; Graham Sumner, Englewood, N. J.; . D. Oakford, John M. Ingham and William M. Clift, Philadelphia. Mr. Hyman is president of the corporation.

ELLWOOD CITY.—The Ellwood Power Company has been taken over by a larger corporation, recently organized under the name of the Pennsylvania Power Company. The incorporators are ... L. Smith, A. J. Barron and B. R. Thomas, all of Pittsburg. The new company expects to put in one or more new dams and to go forward with the development of the water power at Ellwood City. The transmission line is completed to West Pittsburg.

CATASAUQUA.—W. W. McKee, receiver of the Lehigh-Northampton Gas & Electric Company, has been authorized by the Lehigh County Court to issue certificates to the amount of $65,000, the proceeds of which will be used to modernize and enlarge the plants of the company. A direct-connected engine-generator unit and a new Sterling boiler will be installed and all the lines placed in first-class condition. The company now furnishes light in this city, Hokendauqua, Coplay, Cementon, Siegfried and Northampton.

HANOVER.—J. W. Mumper, a local electrician, has been awarded the contract for lighting the streets of this town. The other competitors were the Hanover Light, Heat & Power Company and the Welsbach Company, of Philadelphia. The Hanover Light, Heat & Power Company offered to light the streets from dusk until midnight for $60 per light; the Welsbach people offered their gas lamps on an all-night service for $35 per lamp, while the Mumper bid was for 2000-c.p. electric lights on an all-night service at $64.92, provided he be given a ten-year contract. The Borough Council decided this was the lowest bid and a formal motion was adopted that a contract be entered into with Mr. Mumpher. He will be required to give a bond in the sum of $5000 for the faithful performance of his side of the agreement.

SOUTH CAROLINA.

SUMTER.—The Sumter Light & Railroad Company has secured a franchise for an electric light plant.

LEXINGTON.—Samuel B. George and Julian E. Kaufmann are interested in the construction of an electric light plant, but it is understood that no engineer has been engaged as yet.

CLINTON.—Engineer Charles C. Wilson writes that bids will be received February 15 for the construction of water works and an electric light plant for Clinton. The cost of the plant is estimated at $25,000.

COLUMBIA.—The Columbia Electric Street Railway, Light & Power Company has secured the contract for lighting the city for five years. The contract provides for about 200 lights of 1200 candle-power at $65 per light per year, the lamps to be lighted from 30 minutes after sunset until one hour before sunrise.

SOUTH DAKOTA.

HURON.—E. G. Bowe, proprietor of The Electric Company, writes that it is proposed to install another alternator and engine next season. An additional boiler was recently put in, and it is

intended to increase the capacity of the plant as rapidly as additional demands upon its service require it.

DEADWOOD.—The properties of the Black Hills Electric Light Company, of this city, and the Belt Light & Power Company, of Lead, have been purchased by a new company to be known as the Black Hills Consolidated Electric Light & Power Company, the negotiations for the transfer having been conducted by J. J. Henry, of Denver. It is understood that Harris Franklin and others of this city are assisting to finance the deal. The new company expects to spend a quarter of a million dollars in enlarging and improving the plants now under its control and is planning to furnish electric power to the various mining companies of the northern Hills. The price per horse-power has been reduced, so that it will be cheaper than steam power.

TENNESSEE.

COOKEVILLE.—Bonds to the amount of $25,000 are being issued by the city, the proceeds of which will be invested in an electric light plant and its equipment.

KNOXVILLE.—A bill is to be introduced at the next Legislature, asking for authority to issue $200,000 bonds for the purpose of constructing a municipal electric light plant.

JEFFERSON CITY.—The Jefferson City Electric Company's plant was recently destroyed by fire, entailing a loss of $4000. The company is preparing to rebuild the plant.

TULLAHOMA.—The municipal electric light and water works plant is in the market for a 150-h.p. gas engine and gas producer plant. C. W. Lytle is superintendent, and all communications in reference to the matter should be addressed to him.

MEMPHIS.—A concern known as the Merchants' Power Company has been organized, with a capital of $500,000, to construct and equip a plant to supply private consumers. A plant is also to be built to supply the city, it is said, and the city will have the option of buying either or both of the plants.

KNOXVILLE.—Mr. P. E. Mitchell, who has been acting as superintendent for some months past, has been appointed general superintendent of the Knoxville Electric Light & Power Company to succeed Mr. W. C. Woolfolk, who has resigned. Mr. Mitchell will have general supervision of both railway and lighting departments.

TEXAS.

BAIRD.—The Baird Electric Company is said to have closed its plant in this city.

DALLAS.—The Dallas Electric Light & Power Company contemplates building a new power house.

CORPUS CHRISTI.—The Corpus Christi Electric Light & Power Company is giving its plant a thorough overhauling, which amounts practically to rebuilding it.

GONZALES.—W. L. Gardien, treasurer and manager of the Citizens' Electric Light & Power Company, has resigned his position and sold his interest in the company to Thomas H. Spooner.

ROYSE.—Articles of incorporation, fixing its capital stock at $20,000, have been filed by the Royse Milling & Lighting Company, of this city. J. E. and C. E. Paynter are among the incorporators.

GRANDVIEW.—A concern, to be known as the Grandview Mills, Light & Ice Company, has been incorporated by W. B. Head, R. E. Pitts, T. E. Pittman and others. The company's capital is placed at $20,000, and it is proposed to operate a corn mill, ice factory and electric light plant.

MINERAL WELLS.—Articles of incorporation have been filed by the Mineral Wells Electric Light, Power & Heating Company, which is capitalized at $50,000. V. E. Lycan, of Edna, Mo.; D. G. Galbraith and William D. Williams, of Fort Worth, are the incorporators of the new concern.

SHERMAN.—The Sherman Gas & Electric Company has in operation a plant which is an interesting one for one of its size. Two 250-h.p. Diesel engines are connected to two 160-kw. 250-volt direct-current generators. The generators supply circuits operated on the three-wire system, the system being balanced by means of two independent equalizing sets, each of the sets consisting of two 10-h.p. motors coupled together. Alternating current is also supplied for lighting the outlying districts by means of a 60-kw. alternator direct-connected to a motor which in turn receives its current from one of the generators mentioned above. R. B. Stichter, general superintendent, states that the plant has been in operation for some weeks now and is working very satisfactorily.

UTAH.

PAYSON.—It is proposed to bond the city for $12,000 for improvements to its electric light plant.

AMERICAN FORK.—J. H. Wooten, manager of the Utah County Light & Power Company, has prepared plans for the erection of the proposed light and power plant in American Fork canyon. It will be a combined hydraulic and steam plant and its cost is estimated at about $400,000.

VERMONT.

RUTLAND.—The principal contracts for the equipment of the Chittenden Power Company's hydraulic plant near Rutland have just been determined upon by J. G. White & Company, who have secured the complete contract for the construction and equipment of the plant. The initial installation will have a capacity of 1200-kw. There will be three 400-kw. generators for direct connection to McCormick turbines of 770-h.p. capacity each. The General Electric Company has taken the order for the equipment to be installed in the sub-stations, consisting of three 150-kw. rotary converters. The turbines will operate on a head of 215 feet. Considerable construction work has already been completed on the Chittenden project. Large dams and reservoirs have been built, also a 5-ft. steel conduit 8000 feet long, running from the dam to the site of the power house. The energy will be transmitted to Rutland for general uses. The transmission line will be about seven miles in length. It will operate at 13,000 volts.

VIRGINIA.

NORFOLK.—The Norfolk Railway & Light Company is installing a 1500-kw. Curtis turbine unit to operate on a 2300-volt three-phase alternating-current circuit.

NORFOLK.—Mr. Thomas J. Gates has been appointed assistant city electrician after a competitive examination in which he was successful over seven other candidates.

MARTINSVILLE.—Bonds to the amount of $60,000 have been voted for the improvement of the water power on Smith River to furnish lighting and power current to the town. Half of the issue voted for has already been sold and work on the new plant will begin shortly.

RICHMOND.—Mr. S. C. Midberry, electrician at the Virginia Passenger & Power Company's plant, has resigned to take up new work in New York City. Mr. Midberry was presented with a handsome seal ring by his associates. He is a graduate of Union Polytechnic Institute and the students' course at the General Electric Company's works, Schenectady.

WASHINGTON.

MILTON.—The citizens have voted for a bond issue of $15,000 to establish an electric light and power plant.

SPOKANE.—The Wallace Light & Heating Company, with a capital of $25,000 has filed articles of incorporation.

SPOKANE.—C. C. Van Inwegin, Jr., has sold his interest in the Citizens' Electric Light Company to M. S. Gardner.

DAVENPORT.—John Riley and F. H. Springer have succeeded to the electric light plant of the Davenport Machinery Company.

SEATTLE.—The Seattle Electric Company has petitioned for a franchise to furnish electric light to Renton, a suburb of this city.

BALLARD.—The City Council has granted to L. V. Brewer a franchise to furnish light and power in the city for fifty years.

SEATTLE.—The Seattle Lighting Company has completed its plans for new sub-station buildings and work will be commenced soon.

REARDAN.—J. M. McDowell, of Deer Park, has made application for a franchise to construct and maintain an electric light plant here.

SPOKANE.—General Manager D. L. Huntington, of the Washington Power ompany, states that extensive improvements will be made on the Spokane plant.

ABERDEEN.—The Ninemire & Morgan Company has petitioned for a franchise for an electric light and steam heating plant, the franchise to run fifteen years.

NORTH YAKIMA.—A thirty-year franchise has been granted to the Northwest Water & Light Company. A new system is to be put in by the company and water will be brought ten miles up Naches River.

TACOMA.—The Seattle-Tacoma Power Company's new machinery is in transit. This machinery was ordered for the purpose of doubling the capacity of the Snoqualmie plant. The work preliminary to placing the new unit in position is well in hand.

SPOKANE.—C. A. Luceford, of Davenport, says that the $3,000,000 with which to build the 213-mile electric system through Adams County has been subscribed. Power will be developed at the Narrows near the mouth of the Spokane River. The plant will cost $540,000. W. W. King, of Ritzville, is secretary of the company.

WEST VIRGINIA.

GRAFTON.—A new company has been incorporated, by the name of the Grafton Railway & Light Company, capitalized at $400,000. The company will construct and operate an electric railway and an electric light and power plant in Grafton.

BENWOOD.—The Benwood & McMechen Electric Light Company and the Home Electric Company, of McMechen, have been consolidated and the Ohio Valley Electric Light Company of Benwood and McMechen will begin its existence as an incorporated concern. The articles of incorporation filed by the company state its capital stock to be $50,000, the incorporators being W. H. Snyder, Charles Schad, Robert Newton, of Benwood, and S. E. Dorsey, of McMechen.

WISCONSIN.

RACINE.—A proposition is being agitated here for a municipal electric light plant.

JANESVILLE.—The National Light, Fuel & Gas Company has been incorporated with a capital of $5000.

ALBANY.—Warren & Tompkins, owners of the local electric light plant are making extensions to their system.

OSHKOSH.—The Central Construction Company may apply for a lighting and power franchise here, it is said.

SHEBOYGAN.—Frederick Karste has resigned the presidency of the Sheboygan Light, Power & Railway Company.

MADISON.—The Madison Gas & Electric Company has installed a 600-h.p. Westinghouse steam turbine at its power house.

CAMPBELLSPORT.—The Dundee Water Power & Electric Light Company has recently added an arc circuit to its system.

AMERY.—The Amery Electric Company is extending its commercial lighting circuits and adding a dynamo to its equipment.

MILWAUKEE.—The Milwaukee Electric Railway & Light Company's plant has been damaged by fire to the extent of $5000.

MAYVILLE.—The F. Paustian Milling Company has recently installed in its lighting plant a new boiler, new engines and a new generator.

MANITOWOC.—The Common Council has ordered the city engineer to prepare estimates of the cost of erecting a municipal lighting plant.

SHAWANO.—The managers of the municipal lighting plant are changing the city arc light system from direct current to series alternating current.

CASSVILLE.—It has been voted by the citizens to install an electric light plant. The contract has been let to the Galena Iron Works at $4310.

PLATTEVILLE.—The Platteville Light & Power Company will probably increase both its steam and electrical equipment this year, as both have reached the limit of their capacity.

WATERLOO.—Alexander Archie, E. J. Rood, and others have incorporated the Consolidated Electric Light Company, having a capital stock of $75,000. Mr. Archie is president of the new concern.

MILWAUKEE.—Press reports state that in the budget for 1905 a provision of $400,000 is made for a municipal lighting plant, and it is understood that plans for the building have been filed with the building inspector.

MANITOWOC.—The West Side Electric Company, recently granted a franchise, will at once begin work on the erection of a $200,000 electric plant for furnishing power and heat. Ex-Mayor William Rahr is at the head of the enterprise.

CANADA.

ALVISTON, ONT.—The Alviston Power Company, Ltd., is extending its circuits to provide for about 300 more private lights.

ST. THOMAS, ONT.—Bids will be received February 15 by S. O. Perry, city treasurer, for $200,000 gas and electric light bonds.

CALGARY, N. W. T.—The ratepayers of Calgary have decided in favor of installing a municipal electric lighting system in the town.

CAMPBELLFORD, ONT.—It is proposed to install at the city electric light plant two direct-connected units of 800 kilowatts capacity each.

THOROLD, ONT.—It is proposed to substitute alternating-current series arc lamps for the direct-current lamps now used for lighting the city streets.

OSHAWA, ONT.—The Oshawa Electric Light Company is extending its street lighting circuits and also arranging to increase its service to private consumers.

PETROLIA, ONT.—The Petrolia Electric Light, Heat & Power Company is installing a new street lighting system of alternating-current series enclosed arc lamps.

STRATHROY, ONT.—A new engine room is being built at the municipal electric light plant, and upon its completion a new engine and condenser will be installed.

OTTAWA, ONT.—Application will be made to the Dominion Parliament at its coming session by the Niagara-Welland Power Company for an act authorizing the company to use its proposed canal for navigation purposes, to construct a tramway along its right of way, and to extend the time for the completion of its works.

TORONTO, ONT.—The Ontario Power Company has closed a contract with the Westinghouse Electric & Manufacturing Company for an alternating-current generator with a rated output of 10,000 horse-power at 85 per cent. power factor, designed for direct connection to water wheels. It generates three-phase current at 12,000 volts and 25 cycles and runs at a speed of 187.5 r.p.m. Among other apparatus included in the contract were twelve 3000-kw. oil-insulated water-cooled transformers wound for 12,000 and 60,000 volts; two 375-kw. exciters, and complete switchboards.

HAMILTON, ONT.—The Hamilton Cataract Power, Light & Traction Company has recently started the two 5000-kw. Westinghouse generators in its De Cew Falls power station in Ontario. Power is supplied from Welland canal feeders, tapped in about 14 miles above the power station, and at the station the water has a head of 267 feet. The Westinghouse generators are of the two-bearing type, direct connected to Escher-Wyss water wheels, and run at a speed of 286 r.p.m. They generate three-phase current at a frequency of 66 cycles, and a pressure of 2400 volts. The power is transmitted to this city where it is used for lighting, street railway and manufacturing purposes. A reserve steam-driven station is located at Hamilton, which contains two 1000-kw. Westinghouse generators. The entire station and high-tension apparatus are of Westinghouse design. The company has two separate three-phase transmission lines to Hamilton, a distance of about 35 miles. The high-tension apparatus is designed for a pressure of 40,000 volts, but will be operated for a time at 20,000 volts. Mr. Wm. C. Hawkins is general manager of the Hamilton Company, and is also engineer in charge of the installation.

NIAGARA FALLS, ONT.—The Canadian Niagara Falls Power Company, which is owned by the Niagara Falls Power Company on the American side of the river, set in motion a short time ago two of its 10,000-h.p. turbines. The officers of the power company, the commissioners of the Niagara Falls Queen Victoria Park, and other guests were witnesses. The trial was a great success. These are the largest working turbines and dynamos in the world, and their successful operation marks an important era in electrical development. Francis Lynde Stetson, of New York, and President W. H. Beatty, of the Canadian company, turned on the power, and each unit under full power developed 12,000 volts, and ran without a hitch. At the beginning of the test President Beatty turned on the water for wheel No. 1. The wheel was allowed to reach its full speed of 250 revolutions a minute and then President Beatty threw the switch which placed the generators in action. Wheel No. 2 was thrown on and 20,000 horse-power was developed. The Canadian Niagara Power Company is the first Canadian company to harness Niagara. Five electrical units of 10,000 horse-power each are being installed and six more can be added. The turbines for each unit were designed and manufactured in Switzerland. Each is at the bottom of a pit and attached by a vertical shaft to a 10,000 horse-power generator. The water is led to the driving wheels by penstocks, each of which is ten feet in diameter. The water is discharged through a short tunnel which ends at the water's edge just below the Horseshoe Falls. The tunnel is driven through solid rock and is lined with brick. The Canadian power house is connected with the one on the American side by cables which are carried in conduits through Victoria Park and across the upper steel arch-bridge. The first power from the Canadian plant will be transmitted to Toronto for power and lighting. Much of the power generated at the Canadian plant, will, however, be at the disposal of American consumers. In building the plant it has been so arranged that machinery for developing 100,000 additional horse-power over the present limit, may be installed at any time.

MEXICO.

MALINALTANGO FALLS.—Maj. George B. Burbank and George Stuart Simons, of New York; A. S. Harvey, of Leadville, Col., and Philadelphia capitalists are interested in a project to establish a large electric light and power plant at the Falls near the City of Mexico. About 25,000 horse-power will be generated.

CHAPALA.—Carlos Navarro Mora has been granted a concession by the state government for the establishment of an electric light plant and textile mill at the town of Chapala. The concession specifies that work on the two plants must be commenced within six months, and grants an exemption from all state taxes for a period of ten years. The electric plant will furnish light for the streets of Chapala.

MEXICO CITY.—Mr. David Reyes Retana, of this city, is primarily interested in a concession which is being negotiated for with the Mexican Government looking to the establishment of a large hydro-electric plant on the River Mexcala, State of Guerrero. It is proposed to use at least 60,000 liters of water per second. Half the power to be developed is intended for lighting and manufacturing purposes and the rest for irrigation.

MEXICO CITY.—The Mexican Light & Power Company, Limited, has secured a new contract from the Federal Government of Mexico, for lighting the City of Mexico for a period of ten years. The new contract increases the number of arc lights to 1200 to burn 4000 hours annually. The annual sum to be paid the company by the Mexican authorities is $325,777. The old contract was undertaken by the Mexican Electrical Works, Limited, formerly owned by the Siemens & Halske Electric Company, which was purchased some time ago by the Mexican Light & Power Company. The company is authorized under the new contract to generate current from the old Siemens & Halske steam plant, or from its Necaxa hydraulic plant. Hugh L. Cooper, chief engineer and manager of construction of the company, which is building the 45,000-h.p. Nicaxa-Mexico City-El Oro power transmission system, has resigned his position in order to devote his entire attention to the installation of the Niagara Falls (Canadian side)-Toronto plant and other important projects in the United States and Canada. Before recommencing work, however, he will take a two-months trip to Europe. Mr. F. S. Pearson, vice-president and consulting expert of the Mexican Company, is now in the southern republic looking over the construction of the system.

The accompanying tables already appear on page 93 of this issue in connection with the article on "Changing Magnet Windings for Different Voltages" and are reproduced here for the convenience of those who might wish to cut them out without destroying any of the reading matter in the issue.

Voltage Scale. A	Voltage Scale. B	Voltage Scale. C	Voltage Scale. D	Voltage Scale. E	Voltage Scale. F
1.94	2.02	2.14	2.23	2.32	2.42
2.45	2.55	2.69	2.81	2.93	3.05
3.09	3.21	3.40	3.55	3.69	3.85
3.89	4.05	4.28	4.47	4.66	4.85
4.9	5.1	5.4	5.65	5.9	6.2
6.2	6.5	6.8	7.1	7.4	7.7
7.8	8.1	8.6	9.0	9.4	9.8
9.9	10.3	10.8	11.3	11.8	12.3
12.4	12.9	13.7	14.4	14.9	15.5
15.7	16.3	17.2	18.0	18.7	19.5
19.7	20.5	21.7	22.7	23.6	24.6
24.9	25.9	27.4	28.6	29.8	31.1
31.4	32.6	34.5	36.1	37.6	39.2
39.6	41.2	43.5	45.5	47.4	49.4
50.0	52.0	55.0	57.5	60.0	62.5
63 0	65.5	69.0	72.5	75.5	78.5
79.5	82.5	87.5	91.0	95.	99.
100.	104.	110.	115.	120.	125.
126.	131.	139.	145.	151.	157.
159.	166.	175.	183.	190.	198.
201.	209.	221.	231.	240.	250.
253.	263.	278.	291.	303.	315.
319.	332.	351.	367.	382.	397.
402.	418	442.	463.	481.	500.
507.	528.	558.	583.	607.	*Am. Elec.*

Wire Sizes.
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American Electrician.

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POWER AND LIGHTING EQUIPMENT OF A BROOKLYN MUSEUM

PLANT OF THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES.

BY E. T. WALSH.

The museum of the Brooklyn Institute of Arts and Sciences, located on Eastern Parkway, near Prospect Park when finished will be a large rectangular building 560 feet square, and having four interior open courts. The west wing has been in use for seven years, the central portion is ready for occupancy, and the east wing is now under process of construction.

Since the edifice was first started it has been the policy of the management to generate the electricity necessary for lighting and power service, and as a temporary expedient part of t'·e ground floor of the west wing was dev d to a power plant. The equipment consists of two Ideal engines, one of 125 horse-power and the other of 75 horse-power, which are direct-connected to compound-wound G. E. dynamos. Steam is supplied by two tubular boilers. The completion of the central portion of the museum increased the demand for power far beyond the capacity of this old plant, and the installation to be described was designed to supply the increased demand with a sufficient reserve to provide for future extensions.

The new plant is situated on what will be one of the open courts of the completed museum, and is connected with the main building by tunnels. It is a plain brick structure one story high, with a flat fireproof roof, water-proofed cement floors in the engine and pump rooms, and brick floors in the boiler room and coal vault.. It is well lighted and ventilated by windows generous in size and number. The

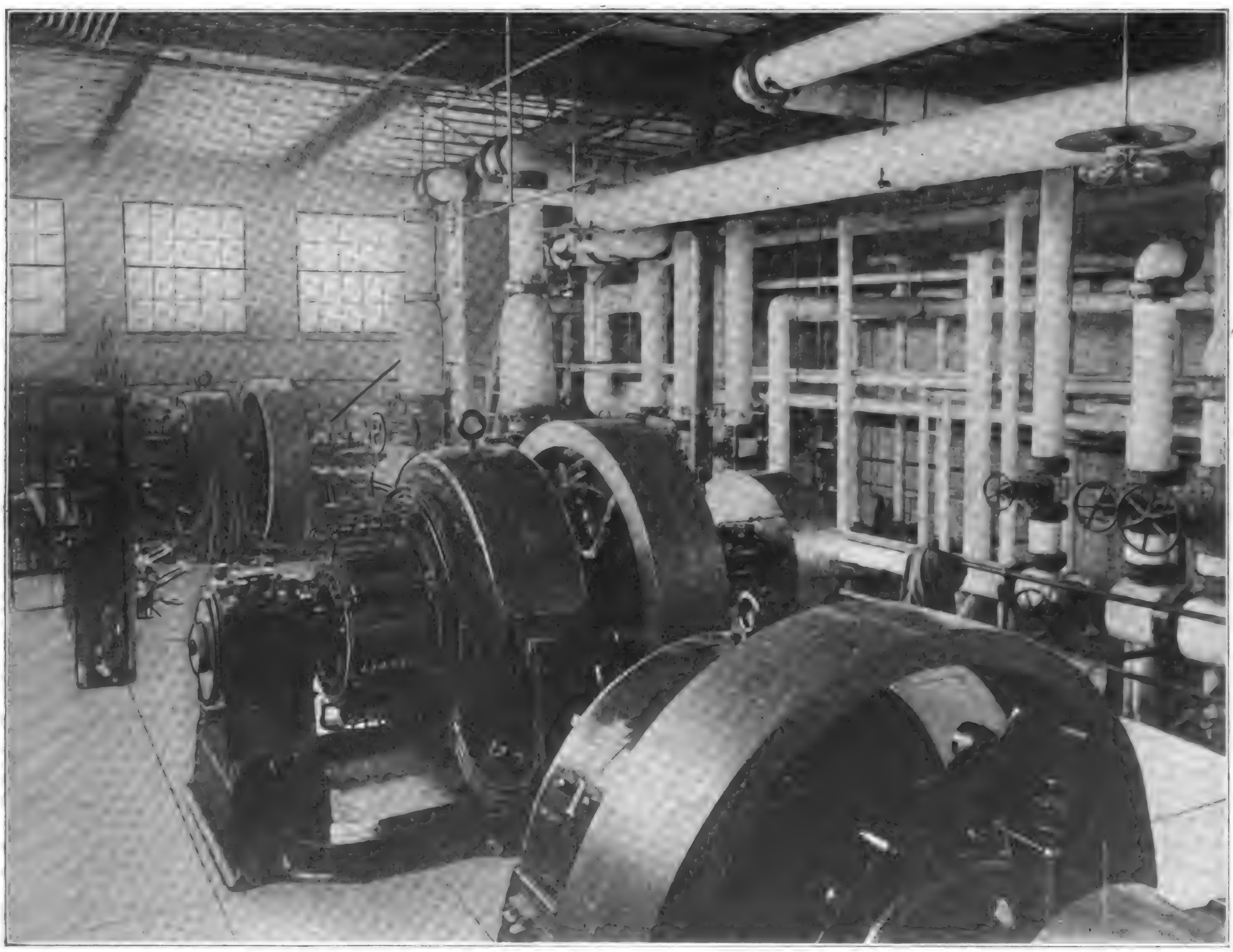


FIG. I.—ENGINE ROOM IN POWER AND LIGHTING PLANT OF THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES.

main part is 84 feet 4 inches long by 52 feet wide, with an ell 14 feet wide by 24 feet 4½ inches long. The building is divided by a brick wall into a boiler and engine room. In one end of the boiler room are the coal bunkers and hydraulic elevator for removing the ashes. Part of the engine room is occupied by the pumps and auxiliaries, together with the steam and water piping. This portion of the room is on the same level with the boiler room. In the ell the chief operating engineer has his office, the floor of which is on the same level as the finished grade of court. At the opposite side of the engine room and on the same level as the office, is located a toilet room containing a closet and lavatory, with lockers for the engineer's assistants.

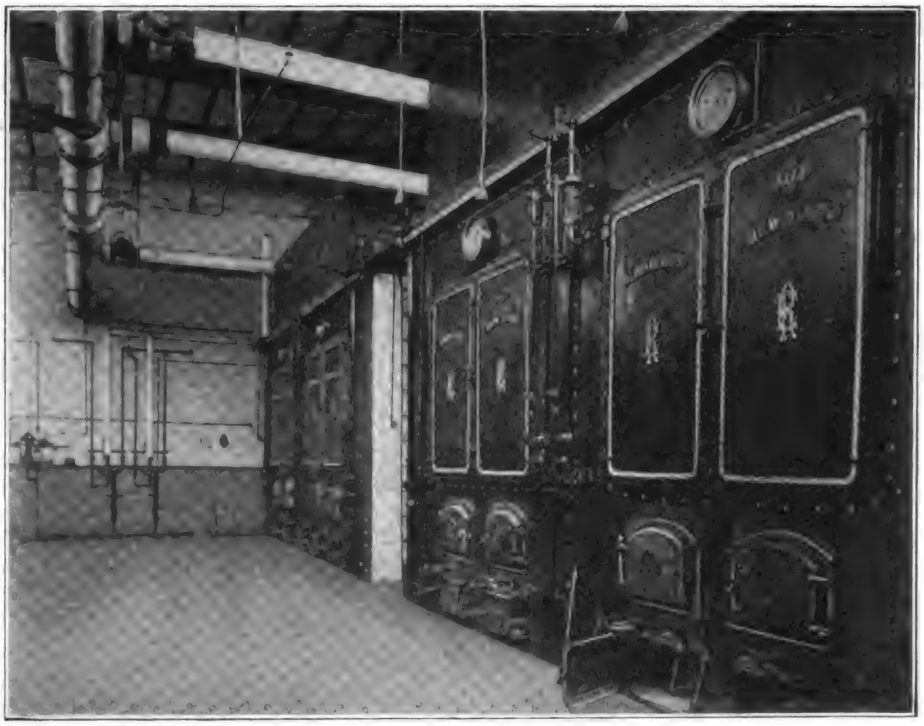


FIG. 2.—BOILER ROOM OF BROOKLYN INSTITUTE POWER PLANT.

Coal is delivered to the plant in carts and deposited in the vault through manholes. The capacity of the coal vault is 500 tons. The ashes are dumped from the grates into a pit and shoveled into barrows and wheeled to the hydraulic lift. The ashes are at present used for filling in purposes, but will ultimately be removed by cart.

There are four boilers of the horizontal return-tubular type in the boiler room, each 78 inches in diameter and 18 feet long, containing 120 American lap-welded tubes 3½ inches in diameter. Each is supplied with a dome 36 inches in diameter by 36 inches high, and has two manholes, one in the front heat under the tubes and the other in the top of the shell. There is also a handhole in the rear head under the tubes. The boilers are supported on heavy cast-iron lugs, eight to a boiler, which have an 18-inch bearing on the wall and 16 inches on the boiler shell, being connected thereto by 1-in. rivets. Where the lugs rest on the wall, 15-inch by 24-inch bearing plates, ⅝ inch thick, were provided, and between these and the lugs twelve ¾-inch steel rollers are placed to permit expansion and contraction. The shells are of ½ inch, and the heads of ⅝-inch flange steel, the dome shells and dome head being of 9-16 inch metal. The horizontal seams are triple riveted, with double butt straps. The seams joining the domes to the shells and the vertical seams of the domes are double riveted and staggered; all other seams are single riveted, the rivets being 15-16 inch in diameter, except in the supporting lugs.

FIG. 3.—AUXILIARY APPARATUS IN ENGINE ROOM.

The boilers are supported and enclosed in a setting of hard burned brick laid in cement mortor with headers every third course, and a brick arch is built about 2 inches above the shell and concentric therewith. The back connection, and the entire setting, where exposed to the flames and products of combustion, are lined with firebrick in fireclay batter. These bricks are bonded into the walls at every third course. Four pairs of extra heavy cast-iron buck-stays are placed on each setting with ¾-inch tie-rods extending across the top of the setting and connecting one buck-stay to its fellow directly opposite, while anchor bolts are used at the bottom of the stays. There are also ¾-inch tie-rods extending from the rear through the entire setting and bolting to the boiler fronts. Each boiler is provided with a sectional front made of ⅜-inch steel plates well bolted together with tee-bars placed on the back. The boilers are set in batteries of two each, and iron ladders are provided to reach the top of the setting for free access to the valves. Each boiler is provided with two 5-inch pop safety valves, set to blow at 90 pounds, and the usual steam gauge, water gauge, etc., that go with a first-class equipment. The grates are of the Swift improved rocking and dumping type, six sections to a boiler, each grate being 6 feet 6 inches by 7 feet.

The smoke and gases pass from each boiler through a wrought-iron breeching into a smoke flue common to each battery, the two smoke flues being connected with the smokestack by an oval smoke connection 54 inches by 66 inches. The stack is 60 inches in diameter inside and 125 feet high. It is of ⅜-inch wrought-iron plates, with lapped joints, and is unlined. The base is well anchored to the foundation with six anchor bolts 1⅜ inches in diameter. The stack is provided with gas-tight clean-out doors placed at a convenient height above the floor level. Each smoke flue is equipped with a positive damper operated by hand from the boiler-room floor, while in the main smoke connection, near the stack, a

swinging damper is located, which is operated by a Kieley automatic damper regulator.

The high-pressure piping consists of steam mains from the boilers to the main engines, the auxiliary header and branches supplying the pumps, and the live steam connection to the heating system. This also includes the high-pressure drip system from the steam mains, and the feed mains from the boiler feed pumps to the boilers, also the blow-off piping to the plug cock.

The low-pressure piping includes the exhaust pipes from the main engines and auxiliaries, the feed and water supply pipes and low-pressure drip piping, and the blow-off piping beyond the plug cock.

Enclosed in the steam dome of each boiler is a 7-inch Potter mesh separator and superheater, to which is joined a 7-inch branch leading to the steam main. These branches have bends in horizontal and vertical planes that provide against strains due to expansion and contraction. Two valves are placed in each branch, one at the separator and the other at the tee in the steam main. The steam main increases from 7 inches in diameter where the first branch connects with it to 12 inches in diameter beyond the last branch. This header passes through the division wall about 12 feet above the floor, after which it descends and delivers to a 12-inch transverse header level with the engine-room floor. The connections to the main engines are taken from the top of this header and are carried over the engines, ending in a De Reyke separator which is connected to the throttle valve. A valve is placed on each of these connections where they leave the header.

The steam for the pumps is taken from the header just mentioned through a 7-inch pipe which forms an auxiliary header, from which all connections to the pumps are taken. From the transverse header is also taken a branch for the purpose of supplying live steam to the heating systems of the central portion and the east wing. There is also a 7-inch connection made through a De Reyke separator to the heating system of the west wing. The high-pressure steam piping throughout is well equipped with valves for the protection and cutting out of any disabled portion of the plant. All high-pressure mains, branch connections, separators, etc., are dripped through Nason traps, which discharge into a high-pressure drip tank. The drip pipes from the mains and from each piece of apparatus are trapped separately and each trap has a bypass. The high-pressure drip tank is 3 feet in diameter by 5 feet long, and is fitted with a manhole in the head, and gauge glass, vapor pipe, etc. This tank is emptied by a pump controlled by a Kieley automatic pump governor discharging into the boiler feed line.

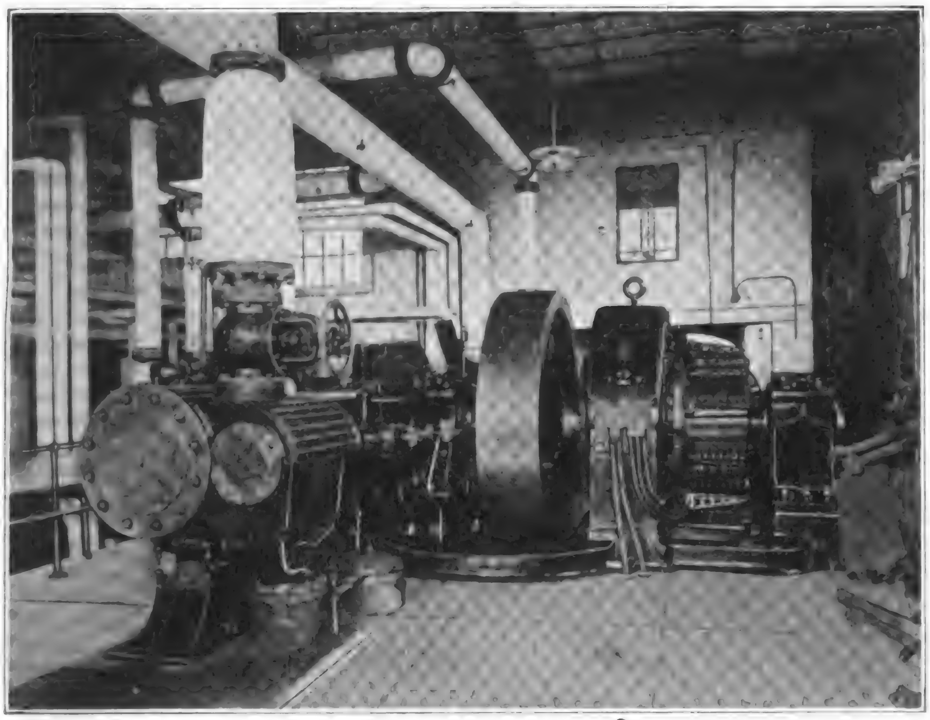


FIG. 4.—VIEW OF ONE OF THE 200-KW UNITS.

The boiler feed-water system consists of a 3-inch supply from the city mains to a 7½ by 5 by 6-inch duplex pump, from which it is discharged into a 3-inch main. The discharge from this high-pressure drip pump is also connected to the main, which connects to a Ward feed-water filter and a Berryman feed-water heater, which is located in the main exhaust system and used as an induction or dead-end heater. The feed line is so arranged that either the filter or the heater, or both, may be by-passed. From the heater the line passes directly over the boiler fronts from which 2-inch branches are taken to feed into Fox water arches which are connected to the boilers. In each branch an angle valve is placed next to the header with a check and straightaway gate valve near the floor between this and the water arch. As an extra precaution, two monitor injectors have been installed in the feed system. These are piped so as to send the water through the filter and heater before it reaches the boiler.

The Ward filter is composed of six cast-iron cylinders, 12 inches in diameter by 7 feet high over all, which are fitted with a complete set of special cast-zinc bars and filled with animal charcoal. It is provided with a removable outside strainer box and has a 3-inch feed-water inlet and outlet. It is built for a working pressure of 150 pounds. The heater used is an induction or dead-end heater which has no exhaust outlet, the action being as follows: Steam from the exhaust enters the heater, filling the steam space around the tubes, and the cold water passing through the tubes condenses some of the steam, thus lowering the pressure in the heater. The continuous flow of cold water through the tubes and the consequent condensing of the exhaust induces a constant flow of steam into the heater, hence the name induction heater. Each pound of steam entering the heater brings with it a certain amount of entrained air. This passes out from the top through a small vapor pipe, which sometimes discharges into the exhaust main, but in this case discharges into the vapor pipe leading to the roof.

The main exhaust header is located directly under the main steam header and begins at the north end of the pump room, running south and ending in a muffler tank. It increases from 8 inches in diameter, where the exhaust from the first engine enters to 10 inches in diameter, where it enters the muffler tank. The exhaust branches from the main engine enter the header at the bottom after passing under the floor in trenches, which are covered with cast-iron floor plates. From the outlet of the muffler tank, the exhaust pipe rises vertically to a 10 by 10 by 10-inch tee, from one outlet of which a 10-inch pipe runs to the heater main. Between this heater main and tee is located the connection to the induction heater. Just beyond the 10 by 10 by 10-inch tee is placed a Kieley back-pressure valve from which a free exhaust, 10 inches in diameter, is carried to the top of the smokestack, ending in a copper exhaust head. The exhaust steam from all the pumps is delivered to this exhaust main through an auxiliary header 7 inches in diameter. Gate valves are used throughout on the main exhaust headers, and on all branches to main engines and pumps. A complete system of low-pressure drips is used, connecting with the exhaust main and branches wherever required from the cylinders of all engines and pumps, the exhaust head, the muffler tank, feed-water heater, etc. This system empties into a low-pressure drip tank. The drips from the exhaust pipe and from each engine pump, etc., are trapped separately.

At the rear of the boilers, directly on the floor, is the blow-off main 3 inches in diameter, which ends in a blow-off tank. Each boiler is connected through a 3-inch branch, which has a 3-inch blow-off plug cock. The blow-off tank is 3 feet in diameter by 8 feet high. It is fitted with a manhole, glass water gauge, etc., and contains a cooling

coil of seamless brass pipe, 3 inches in diameter containing 60 linear feet. The outlet is connected to the blow-off pump, which discharges to the sewer. The sewer being above the level of the blow-off tank, made it necessary to have a pump for this purpose. The boiler blow-off from the boiler shell to the plug cock just outside the setting is of 3-inch extra heavy wrought-iron pipe encased in firebrick.

Vapor pipes 2½ inches in diameter are provided from the blow-off and drip tanks with a valve placed on each. These are connected to a 4-inch main vapor pipe leading to the top of the smokestack and ending in a copper exhaust head.

The pipe used for the high-pressure mains is of standard full-weight wrought iron with extra heavy flange fittings. Pipes above 4 inches have flanged joints packed with copper corrugated gaskets, while those less than 4 inches in diameter have screw joints without any packing. The boiler feed pipes are of iron size hard-drawn brass, with brass fittings. All cold-water pipes are of standard guaranteed full weight galvanized wrought iron with galvanized fittings. Particular care was exercised in installing the live steam exhaust pipes, with a view to preventing noise and vibration.

The valves used on the high-pressure steam pipes are gate valves of extra heavy pattern with ribbed or recessed flanges, bronze discs and seats, and composition spindles and stuffing boxes. The valves on the feed line are of extra heavy brass. All other valves, 2 inches in diameter or less, are of steam metal, with finished trimmings; those over 2 inches have iron bodies and brass trimmings. All valves, except the angle valves used where the feed branch to the water arch leaves the feed main and the plug cocks in the blow-off pipes, are of the gate type.

Magnesia pipe covering is used throughout. The pipes passing through the tunnels and in trenches underneath the engine room floor, have an extra covering of No. 10 canvas drawn tight and neatly sewed and then painted with two coats of fire-proof paint. The domes of the boilers, the feed-water heater, the feed-water filter, all tanks, separators, pump governors, traps, fittings, valves, etc., are covered with magnesia blocks 1½ inches thick, securely wired, the whole neatly covered with a No. 10 canvas jacket and painted with two coats of fire-proof paint.

The smoke connections and the stack up to the roof are covered with magnesia blocks 1½ inches thick, and finished with hard plaster. The covering is placed on a framework of wire net surrounding the smoke connections and stack 2 inches from the iron, thus forming an air space. This covering is painted with black Japan varnish.

The pumps located in the pump room are as follows: Two 7½ by 5 by 6-inch pumps for returning the water of condensation from the receiving tank and for feeding fresh water into boilers; three 6 by 4 by 6-inch pumps for draining the high-pressure and low-pressure drip tanks and the blow-off tank; one 10 by 6 by 10-inch pump for house service, and one 14 by 7 by 10-inch Underwriters' fire pump. These pumps are all of the duplex type, built for a working pressure of 150 pounds. The house service and fire pumps are provided with Ford regulators and safety draining devices.

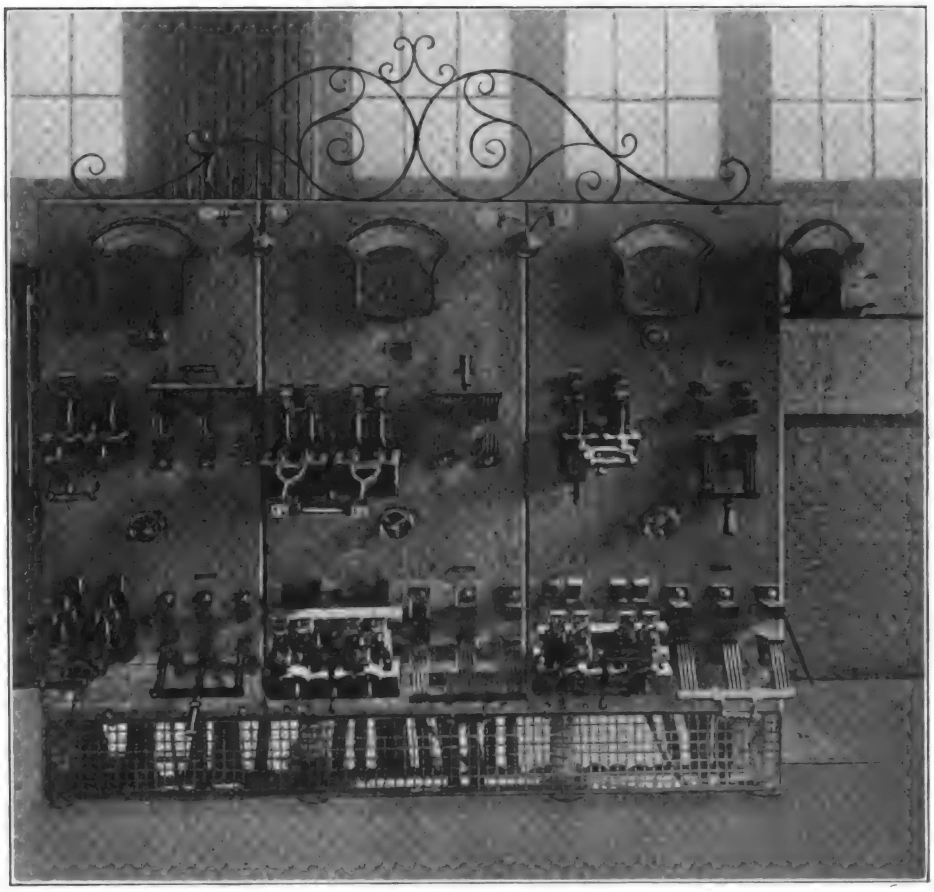


FIG. 5.—MAIN SWITCHBOARD IN ENGINE ROOM.

Three engines of the Harrisburg standard high-pressure type built by the Harrisburg Foundry and Machine Works, of Harrisburg, Pa., furnish the motive power. Two of these have a capacity of 320 horse-power each, and the other has a capacity of 120 horse-power. Following are the principal dimensions of the engines:

	Large engines.	Small engine.
Diameter of cylinder	22 ins.	15 ins.
Length of stroke	20 ins.	14 ins.
Revolutions per minute	200	275
Guaranteed horse-power	320	120
Diameter of steam pipes ...	7 ins.	5 ins.
Diameter of exhaust pipe ..	9 ins.	6 ins.
Type of governor	Fly-wheel governor	
Initial steam pressure	80 pounds	
Point of cut-off	25 per cent	

These engines are of the direct-connected type, the sub-base under each engine supporting the generator and out-board bearing. Each engine is equipped with a Manzel oil pump for lubricating the cylinders.

The dynamos are Keystone multipolar direct-current compound-wound machines, built by the Burke Electric Company, of Erie, Pa., the principal data being as follows:

	Kw.	Speed.	Volt.	Amp.
Large dynamos	200	200 r.p.m.	125	1600
Small dynamo	75	270 r.p.m.	125	600

They are guaranteed to operate under full normal load for twenty-four hours per day without any undue heating.

A rather peculiar arrangement of switchboards has been adopted. The main switchboard in the dynamo room feeds the switchboard used in connection with the old plant. In the central portion another switchboard is located for controlling the lights used there and for lights in the east wing. Still another switchboard, from which the stage lights are manipulated, is located in the auditorium. The main switchboard is made up of three panels of gray Tennessee marble. All exposed work on the face of the board is highly finished in bright copper. The usual instruments, switches and circuit-breakers are provided. The board in the west wing is fed by feeders from the main switchboard, which connect with the bus-bars already in place. The lights used in this wing and the passenger elevator are controlled from this board.

The switchboard in the central portion is equipped with nineteen auxiliary circuit-breakers, nineteen knife switches, one main circuit-breaker, and one main knife switch of 1500 amperes capacity. The other knife switches and circuit-breakers vary in size, depending upon the load they carry. The board is of Tennessee marble trimmed with a nickle frame.

At the rear of the stage in the auditorium is a small switchboard from which the light effect on the stage is controlled. This board has four dimmers mounted upon it, together with numerous switches and fuse blocks.

There are furnished in position the following feeders: One set of cables leading from the main switchboard to the switchboard in the west wing. One set of cables leading from the main switchboard to the switchboard in the central portion of the

building. A set of empty conduits lead from the main switchboard into the central façade, which are to be ultimatley used to hold cables conveying current to this switchboard for the east wing. One set of cables connects each dynamo to the main switchboard. The compensating leads are of the same size as the positive and negative leads. All of the cables are flexible stranded, composed of No. 16 B. & S. conductors having an insulation of rubber and covered with lead armor heavily tinned. The generator leads, however, are not lead armored, but have two layers of tape put on spirally in opposite directions, and are then covered with two substantial braidings well coated with preservative.

For the information and data incorporated in the above, the writer is indebted to Mr. Lewis J. Hart, engineer in charge of the plant.

THE CHEMICAL PURIFICATION OF BOILER FEED-WATER.

BY GEORGE E. WALSH.

The economy secured by the purification of boiler feed-water varies according to the chemical constituents of the water. Very few plants obtain water entirely free from boiler-incrusting constituents. Some mountain streams are quite pure. while others contain so much limestone, gypsum, free sulphuric acid, and magnesium chloride that the efficiency of a boiler is very greatly reduced. Water flowing through peat bogs often contains corrosive acids in such quantity that the life of the boiler is quickly affected, while in the great coal districts feed-water is apt to be heavily impregnated by iron salts and free sulphuric acid.

It has been estimated that a scale of sulphate of lime one-sixteenth of an inch thick will reduce the efficiency of a boiler 14.7 per cent. As there is a difference in the conducting power of boiler scale composed of different chemical compounds, the loss in boiler heating of water varies considerably. In experiments made with boilers coated inside with plaster of Paris and with Portland cement, it was found that it required no more time to heat the water in the boiler coated with plaster of Paris than in a clean one, but in the cement-lined boiler it took 19 to 23 minutes to heat the water to 205 degs. Fahrenheit, while 16 minutes were required in the clean boiler.

The conductivity of the boiler scale is therefore an important consideration. The loss depends upon the kind of scale and not altogether upon its thickness. The relative value of chemical water purifiers is therefore a matter depending on the analysis of the feed-water. Very few boiler-scales are as harmless as plaster of Paris or Portland cement.

The practice of purifying the feed-water is quite general now in large plants throughout the country. Both mechanical and chemical treatment has been carried to a relatively high point of success, and the results obtained indicate a great saving. The purifying and softening of the feed-water is doing away with the mechanical washing and cleaning of the boilers, except at long intervals, and there is a direct saving in boiler repairs and labor of washing that averages from 50 to 75 per cent. Frequent blowing-off for the removal of sludge and scale is also costly in the end.

Of the many chemicals used for purifying feed-water, sodium phosphate is best, and soda ash and lime next. When applied direct in the boiler the soda ash causes the incrusting solids to change to carbonates. When precipitated in the boiler in this form, they can easily be blown off as soft sludge. In their former condition the solids when precipitated in the boiler adhere to the sides and are not easily dislodged except by some mechanical cleaning method. This chemical treatment is inexpensive at the beginning, but it requires frequent blowing-off to remove all particles. In small plants where it is not advisable to build expensive softening plants, it produces good results. This practice must be kept up continually to keep down the boiler-scale, and where very hard water is used sufficient soda must be introduced to cause foaming of the water when blown-off.

The amount of soda ash used to each thousand gallons of water should be 0.16 per pound of magnesium chloride, 0.13 of magnesium sulphate, 0.10 of calcium sulphate, 0.02 of magnesium carbonate, and 0.02 of calcium carbonate.

The phosphate of soda, or tri-sodium phosphate, has been employed very extensively for purifying feed-water for boilers, but it costs three or four times as much as the soda ash. On the other hand, it is more effective in its results, for in precipitating the lime salts it makes them absolutely non-adherent. They are easily blown off, and practically none adhere permanently to the sides of the boiler. To make the effect as great as possible the water should be slightly heated, for the chemical action is very slow without heat. No expensive plant is required for purifying the water with tri-sodium phosphate. A gauged barrel is generally attached to the feed line, and the direct application of the chemicals to the water is automatically obtained.

In all the different treatments of impure feed-water for boilers, the question of the constituents of the water should determine the character of the chemical formula. Manufacturers drawing their boiler feed-water from streams in coal-mining sections have obtained excellent results by means of milk of lime. Lime and soda ash in equivalent amounts have given the best results, however, for in the milk of lime treatment sulphate of lime is left in the boiler, and this of itself is a scale-forming substance.

The treatment of feed-water by chemicals introduced directly into the boiler or pipes is a cheap method for preventing the formation of scale in boilers, but it is unsatsfactory in the end for large plants unless softening machines are employed. The water-softening and purifying plant costs considerable at the outset. But where the boiler feed-water is laden with acids that tend to form boiler scale, it is poor economy to resort to temporary makeshifts.

There are several types of water-softening machines in use, but all of them seek to produce chemical action by means of heat before the mixture enters the feed-water. There are both intermittent and continuous softening plants. In the former the water enters the storage tanks at certain intervals where it is softened and purified chemically. In the latter system the feed is continuous, and the softening and purification goes on without cessation. The flow of the water to the plant operates all the mechanism used, and regulates the action so that no operator is needed to watch it. The chemicals are likewise fed automatically so that perfect uniformity of feed-water can be depended upon. The chemicals are mixed with hot water in the continuous system, and when they enter the feed-water they immediately act upon it. The chemical reaction proceeds automatically until the water is thoroughly softened and the mechanical action of sedimentation is made perfect. A filter finally completes the process.

The cost of softening plants is not so great as the difference in the loss of effective and non-effective boilers proves in the end. The cost for small plants is proportionately larger than for those from 5000 to 20,000 horse-power. Where steel tanks are used, the softening plants cost from $4 to $5 per horse-power for installations. These prices apply to plants below 1000 horse-power. Above this and up to 2000 horse-power, the price of installation runs down from $4 to $3, while from 2000 to 5000-h.p. plants the cost may run as low as $3 and $2. With very large plants the saving is quite remarkable. Although few companies quote prices lower than $2 and $3 per horse-power for large plants, a number have installed 15,000 and 20,000-h.p. plants at a cost as low as $1.20 per horse-power of installation. For such establishments the economy obtained is out of all proportion to the loss that would follow the disuse of softening machines.

The depreciation of softening plants is an item worth considering. Wooden tanks depreciate very rapidly, and unless their cost of construction is much lower than steel they are not good investments. Where reasonable care is exercised steel tanks do not, as a rule, show more than 5 per cent. depreciation a year.

The further cost other than the construction and maintenance of softening plants comes from the chemicals used. Lime and soda ash are fortunately cheap, and so is tri-sodium phosphate, which sells from 4 to 5 cents a pound. A good deal of the commercial lime, however, contains a high percentage of magnesia, and unless a brand containing from 90 to 95 per cent. of lime can be obtained it should be rejected for water-softening purposes. Water which

owes its hardness chiefly to carbonates of lime and magnesia is very easily and cheaply ~~softened~~. ~~Water containing~~ sulphates and other soluble compounds of lime and magnesia is more expensive to purify. The cost of softening waters varies from 1 to 2 cents per 1000 gallons, for while it takes only 2 mills per 1000 gallons to remove 1.42 pounds of carbonate of lime by the lime-water treatment, it requires 1 cent and 2 mills per 1000 gallons to remove ten grains of sulphate of lime, and more in proportion to remove sulphate of magnesia.

The economy effected consists of saving boilers for longer periods of work, and substantial economy in fuel and repairs. It is impossible to secure satisfactory, continuous service from boilers coated with only a thin scale. If plants are not supplied with water-softening machines, the direct application of chemicals to the feed-water will greatly lessen the loss and waste. Scale may ultimately form inside of boilers thus treated, unless watched carefully and the precipitated sediment blown off systematically. But the saving is considerable even where this practice is resorted to.

A saving of 15 to 16 per cent. in the efficiency of a boiler is a factor in the operation of a steam plant that amounts to a large total at the end of a year. But if one adds to this a saving of 15 per cent. in the fuel another stage in the question of economy is reached that appeals more directly to the cost of operation. A number of tests carefully computed show that the average saving in fuel runs from 10 to 16 per cent. Even in using Lake Michigan water, which contains 12.16 parts of scale-forming substances, a saving in coal amounting to 25 to 35 cents per ton has been effected by the use of water-softening plants.

Only an approximate estimate of the actual saving effected in purifying and softening feed-water before it enters the boiler can at best be obtained, but sufficient tests and practical data are available to show that it is a vital question in modern steam-operated plants. The fact that some reports indicate the loss with ordinary feed-water is inconsiderable shows that the quality of the water used is unusually good. The loss of one plant, however, need not, necessarily be that of another. Feed-water must be taken into account in estimating the cost of operating a plant in any given part of the country. An analysis of the water should be made before the first stone of the foundation has been laid. Otherwise, the question of cost of operation may materially differ from the first figures given.

Sulphate of lime deposits its scale in the boiler so gradually that the danger is often misunderstood. But the scale increases in concentration and hardening until the coating becomes a permanent barrier against free heat conductivity. Many other scale-forming substances are deposited much faster than sulphate of lime, and they are correspondingly easier to remove. Some feed-water heaters will partly neutralize these deposits, and they are sometimes removed in considerable quantity by scum-catchers or blow-off cocks. But all the carbonate of lime cannot be removed in this way.

PREDETERMINATION OF SOLENOID CHARACTERISTICS.

BY PAUL C. PERCY.

In order to work a solenoid to best advantage, it should be proportioned so that when the plunger is all the way in, the magnetic density in it is extremely high. The writer has been accustomed to make the magnetic circuit such that when the plunger is "home," the calculated density in it is about 120,000 lines per square inch and in the yoke or exterior portion of the circuit about 60,000 lines per square inch. The "neck" of the solenoid, or that part through which the plunger slides, should be long enough to make the magnetic reluctance of the annular air-gap there very low as compared with the main air-gap when the plunger is in its idle position; a good proportion for ordinary work is obtained by making the annular air-gap ten times the area of the plunger cross-section. This is accomplished with sufficient closeness by making the length of the neck 2½ times the diameter of the plunger.

It is necessary to interpose a non-magnetic buffer between the inner end of the plunger and that part of the magnetic

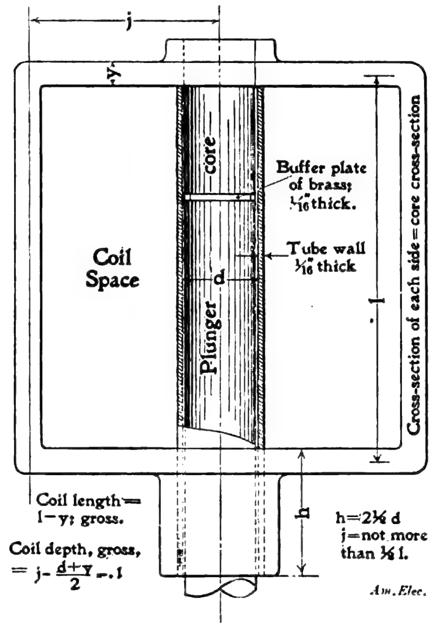


FIG. 1.—STOPPED SOLENOID.

circuit against which it would otherwise be drawn when the solenoid is excited; if this is not done, the plunger will not release promptly when the coil is disconnected from the supply source. A brass plate or screw-head 1-16 inch thick will answer this requirement. The plunger must also be prevented from making magnetic contact with the neck of the frame; a brass bushing with a 1-16-in. wall will serve here. This makes two air-gaps each 1-16 inch long when the plunger is "home," the cross-sectional areas of which have a ratio of 1 to 10 if the plunger is flat-ended.

Coning the end of the plunger and recessing the stationary part of the frame to match it have the effect of making the pull more nearly uniform throughout the travel of the plunger, but as this complicates the calculation of the air-gap and does not increase the initial pull, all other factors being the same, the writer prefers a plain, flat-ended plunger, co-operating with a stationary flat-ended core of the same diameter inside the coil. This article, therefore, is based on a "stopped" solenoid of this type, as shown by Fig. 1.

It will be found that in practice the length of the magnetic path in the yoke need never exceed twice the length of path in the core and plunger when the latter is against the buffer; if it should exceed this proportion, the plunger travel will usually be so small in comparison to its diameter that an ordinary electromagnet could be used to advantage.

Good machinery steel, such as plungers and cores are usually made of, requires about 470 ampere-turns per inch of length for magnetization at 120,000 lines per sq-in.; cast steel yokes at 60,000 lines density require about 15 ampere-turns per inch of magnetic path length. The air-gap between the ends of the plunger and core will require 2350 ampere-turns when the plunger is "home," and the annular air-gap will require 235 ampere-turns under the same condition. Therefore, the total excitation required to produce a magnetic density of 120,000 lines per square inch in the plunger when it is against the buffer plate or screw will be $2585 + 500\,l$; l being the active length of the core and plunger as indicated in the diagram, and the path length in the yoke being taken as twice the value of l. To cover the looseness of the plunger in the brass bushing at the neck the ampere-turns for the two air-gaps may be reasonably made 2600 instead of 2585; then we have the relation:

$$\text{Ampere-turns} = 500\,l + 2600 \quad . \; . \; . \; . \quad (a)$$

Table I is calculated on this basis and will serve for most practical cases.

TABLE I.

Ampere-turns for Different Core + Plunger Lengths.

Core + plunger length.	Ampere-turns.	Core + plunger length.	Ampere-turns.	Core + plunger length.	Ampere-turns.
1 1/2	3350	4 3/8	4788	9 1/2	7350
1 5/8	3412	4 1/2	4850	9 3/4	7475
1 3/4	3475	4 5/8	4912	10	7600
1 7/8	3538	4 3/4	4975	10 1/4	7725
2	3600	4 7/8	5038	10 1/2	7850
2 1/8	3662	5	5100	10 3/5	7975
2 1/4	3725	5 1/4	5225	11	8100
2 3/8	3788	5 1/2	5350	11 1/4	8225
2 1/2	3850	5 3/4	5475	11 1/2	8350
5/8	3912	6	5600	11 3/4	8475
2 3/4	3975	6 1/4	5725	12	8600
2 7/8	4038	6 1/2	5850	12 1/4	8725
3	4100	6 3/4	5975	12 1/2	8850
3 1/8	4162	7	6100	12 3/4	8975
3 1/4	4225	7 1/4	6225	13	9100
3 3/8	4288	7 1/2	6350	13 1/4	9225
3 1/2	4350	7 3/4	6475	13 1/2	9350
3 5/8	4412	8	6600	13 3/4	9475
3 3/4	4475	8 1/4	6725	14	9600
3 7/8	4538	8 1/2	6850	14 1/4	9725
4	4600	8 3/4	6975	14 1/2	9850
4 1/8	4662	9	7100	14 3/4	9975
4 1/4	4725	9 1/4	7225	15	10100

The next step is to determine the approximate pull of the solenoid, or to pro-

portion it to give a predetermined pull. In considering this part of the problem, the writer has based all calculations on the fundamental formula for the tractive force of a magnet when the armature is in contact with the polefaces. This, of course, is inaccurate for a solenoid when there is an appreciable air-gap between the ends of the stationary core and the plunger, but it gives results in favor of the solenoid—that is, the actual pull is greater than the calculated pull—in most cases.

At any given magnetic density in the core, plunger and main air-gap, the ampere-turns required to force the flux through the different parts of the magnetic circuit are readily ascertained; deducting the ampere-turns required by the core, plunger, yoke and neck air-gap from the constant ampere-turns in the coil, which is always equal to 500 l + 2600, leaves the ampere-turns available for the main air-gap. Dividing these by the ampere-turns per inch required at the given density obviously gives the length of main air-gap at which the assumed density will be obtained. Table II has been computed in this way, and will usually give results better than those desired, provided the steel used in the frame and plunger is of good magnetic quality.

The table is instructive in several particulars aside from its value in determining actual dimensions. It shows, for example, that in order to work at high magnetic densities in the core and main air-gap, the magnetizing coil must be enormously long in comparison with the plunger travel; thus, if one wished to lift 100 pounds through a travel of ¾ inch with a core not over 2 inches in diameter, the density would need to be about 50,000 lines per square inch of cross-section, and the length of coil necessary for ¾ inch travel might be 21½ inches.

TABLE II.
Relation Between Plunger Travel, Maximum Coil Length, Density in Core, and Pull.

The numbers in the body of the table are maximum allowable lengths of the magnetizing coil.
The numbers at the heads of columns are magnetic densities in the core, in kilo-lines per square inch.

Plunger travel, in	60	55	50	45	40	35	30	25	20	15	10	7	Plunger travel, in.
1/2	17 1/4	15 1/4	13 1/4	11 3/8	9 3/8	7 1/2	5 3/4	3 7/8	2	....	....	....	1/2
5/8	22 1/4	19 3/4	17 3/8	15	12 5/8	10 3/8	8 1/8	5 7/8	3 5/8	....	....	....	5/8
3/4	27 1/4	24 1/4	21 1/2	18 5/8	15 7/8	13 1/4	10 1/2	7 7/8	5 1/4	2 1/2	....	....	3/4
7/8	32 1/8	28 7/8	25 1/2	22 1/4	19 1/8	16	12 7/8	9 7/8	6 3/4	3 3/4	....	....	7/8
1	....	....	29 5/8	25 7/8	22 3/8	18 7/8	15 3/8	11 7/8	8 3/8	5	1 1/2	....	1
1 1/8	....	....	....	29 1/2	25 5/8	21 5/8	17 3/4	13 7/8	10	6 1/8	2 5/16	....	1 1/8
1 1/4	....	....	....	....	28 7/8	24 1/4	20 1/8	15 7/8	11 5/8	7 3/8	3 1/8	....	1 1/4
1 3/8	....	....	....	...	....	27 3/8	22 1/2	17 7/8	13 1/8	8 1/2	3 7/8	....	1 3/8
1 1/2	....	....	....	....	....	30 1/8	25	19 7/8	14 3/4	9 3/4	4 3/4	1 3/4	1 1/2
1 5/8	....	....	....	....	....	....	27 3/8	21 7/8	16 3/8	10 7/8	5 1/2	2 1/4	1 5/8
1 3/4	....	....	....	....	....	....	29 7/8	23 7/8	18	12 1/8	6 1/4	2 13/16	1 3/4
1 7/8	....	....	....	....	....	....	....	25 7/8	19 1/2	13 1/4	7 1/8	3 3/8	1 7/8
2	....	....	....	....	....	....	....	27 7/8	21 1/8	14 1/2	7 7/8	4	2
2 1/4	....	....	....	....	....	....	....	31 7/8	24 3/8	16 7/8	9 1/2	5	2 1/4
2 1/2	....	....	....	....	....	....	....	....	27 1/2	19 1/4	11	6 1/8	2 1/2
2 3/4	....	....	....	....	....	....	....	....	30 5/8	21 5/8	12 5/8	7 1/4	2 3/4
3	....	....	....	....	....	....	....	....	....	24	14 1/4	8 3/8	3
3 1/4	....	....	....	....	....	....	....	....	....	26 3/8	15 3/4	9 1/2	3 1/4
3 1/2	....	....	....	....	....	....	....	....	....	28 3/4	17 3/8	10 1/2	3 1/2
3 3/4	....	....	....	....	....	....	....	....	....	....	19	11 5/8	3 3/4
4	....	....	....	....	....	....	....	....	....	....	20 1/2	12 3/4	4
4 1/2	....	....	....	....	....	....	....	....	....	....	23 3/4	15	4 1/2
5	....	....	....	....	....	....	....	....	....	....	26 7/8	17 1/8	5
5 1/2	....	....	....	....	....	....	....	....	....	....	30	19 3/8	5 1/2
6	....	....	....	....	....	....	....	....	....	....	....	21 5/8	6
7	....	....	....	....	....	....	....	....	....	....	....	26	7
8	....	....	....	....	....	....	....	....	....	....	....	30 3/8	8
Pull co-efficient=	39.2	32.9	27.2	22.0	17.4	13.3	8.8	6.8	4.3	3.5	1.1	0.53	

Note: The pull in pounds is approximately equal to $D^2 \times$co-efficient. The core diameter, D, required is approximately equal to $\sqrt{\text{pull} \div \text{co-efficient}}$.

A couple of examples taken from practice will serve to illustrate the application of the tables and the method on which they are based. Suppose one wishes to build a solenoid to lift 75 lbs. 1¼ inches. To use Table II, the density must be 40,000 or less because no coil lengths are given for densities above 40,000. It will always save time and trouble to tabulate trial values. In the present case the following preliminary tabulation would be made:

Core density.	Core diameter.	Coil length.	Ampere-turns.
20,000	4.18	11 5/8	8162
25,000	3.32	15 7/8	10540
30,000	2.92	20 1/8	12663
35,000	2.375	24 1/4	14725

From this it becomes evident that either 25,000 or 30,000 lines density is preferable to the others; the writer's preference would be for a 3-inch core and a trifle under 30,000 lines per square inch. A solenoid built for this duty had a 3-inch core, a coil 18 inches long and an excitation of 12,400 ampere-turns.

As the second example, suppose 30 lbs. must be lifted 1 inch. The following preliminary tabulation will be made:

Core density.	Core diameter.	Coil length.	Ampere-turns.
15,000	3.46	5	.5100
20,000	2.65	8 3/8	6788
25,000	2.1	11 7/8	8538
30,000	1.85	15 3/8	10288

In this case the writer adopted a 2-inch core with a coil 12 inches long. The excitation required by test was 8400 ampere-turns.

It should be remembered that the method herein described is not intended to give absolutely accurate results, nor to enable one to determine dimensions and excitation within 1 per cent. or 2 per cent. It is useful in getting at approximate dimensions and excitation, however, and after a little experience in its use, one readily develops sufficient judgment to design a stopped solenoid which requires no alteration in the frame and core. The exciting coil may be laid out by means of the article by the editor of this journal which appeared in the January, 1904, number.

STEAM PIPES.

BY R. T. STROHM.

A system of steam piping which is correctly designed and properly installed adds greatly to the continuous working capacity of a plant, since it insures comparative freedom from annoying accidents and occasional shutdowns which are all too frequent in plants badly designed or improperly erected. For the steam piping is to the plant what the system of blood-vessels is to the body. A defect in either must inevitably cause trouble.

The steam piping in a power plant may be divided into a number of classes. There is the main steam pipe, connecting the boilers and the engines; the piping which supplies steam to the boiler feed pumps and other auxiliary apparatus; the exhaust piping from the engines; and the steam heating system. In this article, however, only the main steam pipes to and from the engines are considered.

Steam mains are made sometimes of cast-iron for very low pressures, but for ordinary power plant boiler pressures they are usually of wrought-iron pipe, either lap or butt-welded. Steel is also used as

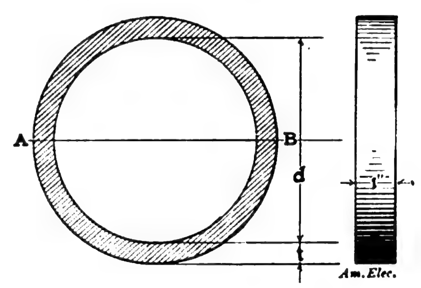


FIG. 1.

piping material, and it has steadily grown in favor during recent years for pipes subjected to the action of high-pressure and superheated steam.

The main steam pipe is such an important part of the steam plant equipment, and its failure is fraught with so many possibilities of disastrous consequences, that too much care cannot be exercised in the selection of the material and in its erection. A cylindrical pipe subjected to internal pressure is in the same condition as a cylindrical boiler under pressure. The stress on a section of pipe one inch long, tending to tear it into two parts, is equal to the steam pressure (p) in pounds per square inch multiplied by the diameter (d) of the pipe in inches. If t equals the thickness of the pipe in inches, the cross-section per inch of pipe length at each end of the diameter AB, Fig. 1, is $t \times 1 = t$ square inches. As the stress $p \times d$ is resisted by the metal at A and B, it is evident that $\frac{p\,d}{2}$ is the stress on each section. Denoting the

safe fiber stress by f, the formula for the thickness of a pipe becomes $t = \frac{pd}{2f}$. For cast-iron pipe, the value of f should not be greater than 1800 pounds per square inch. Of course, for pipes of small diameter, this rule will give the thicknesses too small to be cast easily or successfully, so that the actual thickness will need to be greater than the calculated thickness.

In the case of lap-welded wrought-iron pipes, the value of f should be about 3000, which gives a factor of safety of about 15. Considering that a steam pipe is subjected not only to stresses due to steam pressure, but also to others caused by the change in temperature, this factor is not excessive. Mild steel, such as is used for steam pipes has a tensile strength of about 50,000 pounds per square inch. If this value is much increased, the steel becomes too brittle for satisfactory working. Taking a factor of safety of 15, the safe fiber stress (f) to be used in the case of steel pipes becomes approximately 3500 pounds.

Pipes made of mild steel may be either drawn or welded. In the comparatively small sizes, they are easily solid-drawn, but above 8 or 10 inches diameter welding is resorted to. A solid-drawn pipe, when properly finished, presents smooth internal and external surfaces, and is free from scale or grooves. These pipes should always be annealed after being drawn, to reduce the internal stresses set up during the drawing and cooling processes. In the case of cast-iron pipes, the cooling stresses cannot easily be avoided, and on this account the factor of safety for that material approaches 20.

Welded steel pipes are made by bending the plates and making a longitudinal lap weld. This, if properly done, should give a strong and safe construction. In some instances, however, the security of the welded joint was doubted, and accordingly a narrow strap was riveted to the pipe, longitudinally, covering the entire weld, in order to strengthen the joint.

A main steam pipe should be proportioned so as to deliver the required amount of steam at the given pressure, with a minimum loss of pressure in the transmission. Steam, in flowing through a pipe, suffers a loss in pressure due to the resistance of the pipe walls, bends and fittings, as well as to a certain amount of radiation which cannot be prevented. Experience has taught that the steam in a pipe leading from the boiler to the engine should travel at not more than 6000 feet per minute. Hence, to find the size of steam pipe required to supply a given engine, one may use the formula

$$d = D\sqrt{\frac{S \times r.p.m.}{36{,}000}} \qquad \text{(1)}$$

in which

d = internal diameter of steam pipe, in inches.

D = diameter of engine cylinder bore in inches.

S = piston stroke of engine in inches.

$r.p.m.$ = revolutions per minute.

This rule assumes that steam follows the piston throughout the entire stroke. In reality, of course, the steam flows into the cylinder up to the point of cut-off, after which there is a cessation of flow until admission occurs at the other end of the cylinder. The flow of steam through the end of the pipe opening into the steam chest is therefore a series of pulsations, of greater or less frequency, depending upon the rotative speed of the engine. To insure sufficient capacity, however, the pipe is made large enough to supply the engine if it should take steam throughout the full stroke.

If the engine makes a very large number of revolutions per minute, trouble will be experienced by wire-drawing of the steam during admission. This causes a decided downward slope of the indicator card steam line, instead of the usual horizontal line so familiar in the indicator diagrams of slow-running engines. To avoid, or at least to mitigate this evil, a receiver may be placed near the engine. This receiver, having a volume greater than that of the cylinder, acts as a reservoir, with the result that a more uniform pressure is obtained during the admission period.

Nevertheless, the initial pressure in the cylinder will be less than the boiler pressure because of the resistance to the flow of steam offered by the pipe and its various connections. The drop in pressure varies directly as the length of the pipe. But a large pipe will offer less resistance than a small pipe of equal length, other conditions being the same. It is frequently desired to know what loss of pressure may be expected from a steam pipe of given length and diameter, knowing the initial pressure and the amount to be discharged. For a problem of this nature, the following formula may be used:

$$p' = \frac{W^2 L k}{7{,}500{,}000{,}000\, w} \qquad \text{(2)}$$

in which

p' = loss of pressure in pounds per square inch.

W = discharge of steam, in pounds per minute.

L = equivalent length of pipe, in feet.

w = weight of a cubic foot of steam, at the given initial pressure, in pounds.

$$\text{and } k = \frac{1 + \frac{3.6}{d}}{d^5} \times 1{,}000{,}000.$$

The accompanying table gives values of k for standard pipe sizes. It will be observed that L is given as the *equivalent* length of pipe. By this is meant the length of straight pipe of the given diameter which will give the same friction as the pipe under consideration, with all its elbows and valves. It is evident that the change of direction in an elbow or in a globe valve will add considerably to the friction, and so it is necessary to consider each right-angled elbow as equivalent to a length of straight pipe 40 times its diameter, and a globe valve as equivalent to a length of straight pipe 60 times its diameter. Thus, if a given steam pipe 4 inches in diameter and 40 feet long contains three elbows and two globe valves, the equivalent length of 4-inch pipe is 120 feet, since the three elbows are equivalent to 480 inches, or 40 feet of straight pipe, and the two globe valves are equivalent to 480 inches, or 40 feet of straight pipe.

TABLE I.

Values of k in Formula (2).

Pipe diam. =	3	3½	4	4½	5	6	7	8	10	12
Value of k =	9050	3860	1855	975	551	205.8	90	44	13.6	5.225

Formula (2) may be used to calculate the diameter of a steam pipe, knowing the initial pressure, the allowable drop in pressure, the length of pipe, and the quantity to be discharged, or it may be used to determine the discharge of steam from a pipe, under certain known conditions. In finding the amount of steam discharged, however, there is one peculiarity to be remembered regarding the flow of steam. When the discharge pressure becomes as low as 58 per cent. of the initial pressure, the weight of steam discharged in a given time becomes a maximum. No further lowering of the discharge pressure will increase the flow, not even if the steam is caused to flow into a partial vacuum.

In exhaust steam mains it is not desirable to have the velocity of the steam exceed 4000 feet per minute. Consequently, for exhaust piping, formula (1) may be changed so as to read

$$d = D\sqrt{\frac{S \times r.p.m.}{24{,}000}} \qquad \text{(3)}$$

in which the letters used have the same significance as in formula (1).

It frequently happens that one main pipe must receive the combined discharge from a number of smaller branch pipes, or must convey sufficient steam to supply a number of branches successively. An instance of

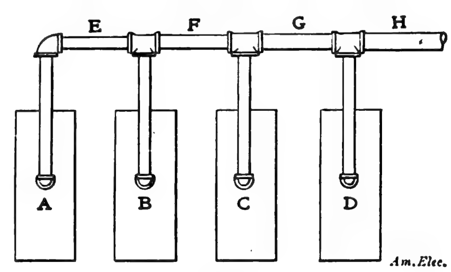


FIG. 2.

this is to be found in a steam main connecting a number of boilers as indicated in Fig. 2. It is obvious that the section of pipe, E, between the boilers A and B carries simply the steam generated in the boiler, A. But the section, F, must convey the discharge of both boilers, A and B. Hence, the area of the pipe, F, must be twice the area of the pipe, E. Similarly, the area of the pipe, G, must be three times that of E, and of H must be four times that of E. Thus the

pipe, *H*, must have a diameter twice as great as the diameter of the pipe, *E*; since the areas are proportional to the squares of the diameters. This arrangement of the main is not a desirable one.

The sections of pipe may be joined either by screwed or flanged joints. For the small sizes of wrought iron and steel pipe, the ordinary unions and couplings are used. In larger sizes, however, flanges are required. The manner in which the flanges are joined to the pipe is an important de-

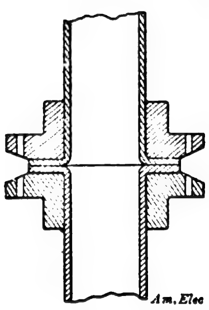


FIG. 3.

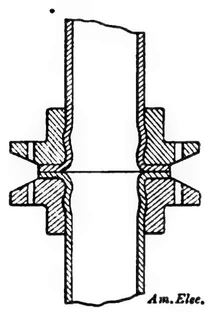


FIG. 4.

tail. The usual method of screwing the pipe into the flange has the disadvantage that it is liable to leak. Some manufacturers have sought to guard against this by making the threaded joint considerably longer, giving a greater number of threads in contact, and by thus having a longer hub lessening the liability of the flange being loosened by vibrations.

In fitting flanges to pipes the pipe should be screwed through the flange until it projects about 1-16 inch. After peening, the pipe should be put in a lathe and the projecting end cut off. Then a light cut should be taken across the entire face of the flange, which will insure its being at right angles to the pipe axis. Much of the trouble due to leaky flanged joints may be traced to neglect of this precaution, the flanges being therefore out of line at the time of erection. Flanges may be made of cast iron, wrought iron or steel.

Another method of obtaining a tight joint is illustrated in Figs. 3 and 4. The flange is slipped over the pipe and the pipe is then flanged over, as shown. In the method shown in Fig. 4, the additional precaution is taken of expanding the pipe into grooves in the flange. The riveting of cast-iron flanges to wrought-iron pipe is not to be commended, as any continued vibration is almost certain to loosen the joint and eventually cause leakage around the rivets.

PARALLEL OPERATION OF DYNAMOS HAVING DIFFERENT CHARACTERISTICS.

BY LAMAR LYNDON.

Generators are compounded for the purpose of maintaining a practically constant voltage at the end of the feeders. Theo-

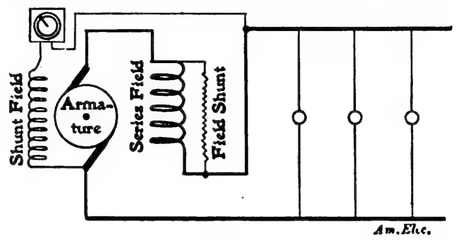


FIG. 1.

retically the compounding is adjusted so that the increase in dynamo voltage, produced by the magnetizing effect of the main current which flows through the series coils, is just equal to the increase in feeder drop due to increase of current flow. In this way the volts due to the compounding effect of the series windings are always equal to the volts of drop in the feeders. By the

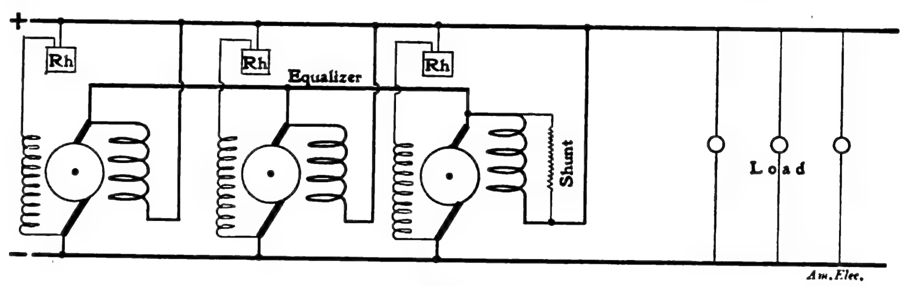


FIG. 2.

term "compounding effect" is meant the effect of increasing the voltage at full load above the voltage at no load; the compensation for internal losses in the generator—which requires some of the magnetization of the series winding—is not here taken into consideration.

The foregoing explanation, though seemingly unnecessary, is gone over to show that where a number of generators are run in parallel there is a certain number, only, of the machines in operation with which the increase of voltage due to compounding is equal to and neutralizes the feeder drop. If the number of machines in parallel differs

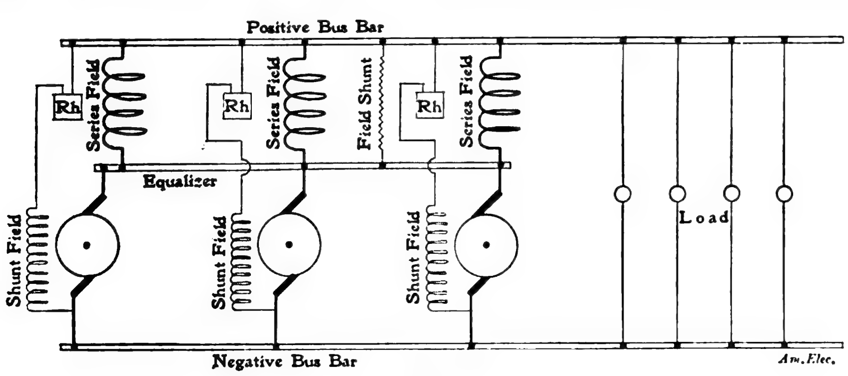


FIG. 3.

from this number, the desired equality between voltage increase and drop no longer exists.

Assume, for example, two generators, each of 1000 amperes capacity, giving 500 volts at no load and 550 volts at full load, and a system of feeders carrying 2000 amperes with 50 volts drop. When the load on the system is equal to the full capacity of both machines, the drop over the feeders is just equal to the increase in generator voltage. When, however, the load drops to 900 amperes and one machine is cut out, the compounded voltage of the working machine—assuming a straight line characteristic at this range—will be about $50 \times \frac{900}{1000} = 45$ volts. The drop in the line, however is only $50 \times \frac{900}{2000} = 22.5$ volts. That is, the compounding that is suitable for both generators is excessive for a single one, working on the same system of feeders, and to preserve constant pressure at the ends of the feeders, hand regulation must be employed. Obviously, on the other hand, if the compounding were of proper value for a single machine it would be too low for the full output of two machines.

Usually generators are built for about 10 per cent increase of voltage at full load above that at no load. The actual magnetization produced by the series turns may vary considerably with the character of the iron, the air gap and other constants of construction. Therefore, it is general practice to put on more turns than necessary, and by shunting part of the current out of the winding adjust the actual voltage rise to the desired value. Fig. 1 illustrates this method of adjustment.

Fig. 2 shows diagrammatically three machines in parallel, all of them having their series coils connected between the positive and equalizer bus-bars, and one of the machines having its series field winding shunted. By following the connections, it will be clear that the shunt strip is in effect also connected between the positive and the equalizer bus-bars, and therefore a shunt across the series coils of any machine is a shunt across all of them. This is indicated in Fig. 3, which is the equivalent electrically of Fig. 2. This explains why it is impossible to adjust compound-wound machines with series field shunts when several of them are connected in parallel.

In parallel running the series field windings are all connected in parallel, and may be considered as being supplied from a source of current having a low e.m.f. varying directly as the load varies. Referring to Fig. 3, it will be clear that the drop through any series winding must be the same as that of each of the others for any given load, regardless of the size or capacity of the ma-

chines which are working together, since they are all connected across the positive and the equalizer bars. In parallel operation, therefore, series field shunts serve only to pass the generator current in excess of that carried by the series coils, and are in no sense voltage adjusters of individual machines with reference to the others.

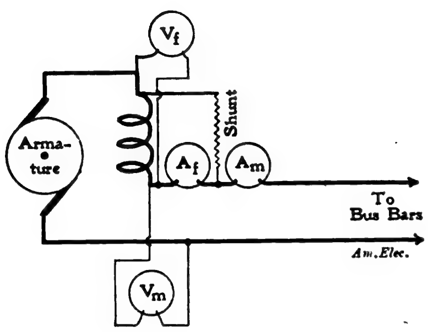


FIG. 4.

When the characteristics of the several dynamos differ, there is generally one value only of the load at which the total current is exactly divided among the machines in proportion to their respective capacities. It is usual to fix the full load output as that at which this proper load division shall take place. With loads less than the full rated output, the fact that the several currents are not exactly proportional to the capacities of the various generators is of little moment, since each one of the machines is running at less than its normal rated output, and the total efficiency of the station is not appreciably affected if the output of some machines is 80 per cent. and of others 70 per cent. of their normal rating.

With these facts understood it is practicable to pass to the consideration of a definite case of paralleling several generators having different characteristics. Assume that in rearranging and changing over machinery there are available for station equipment five generators as follows:

No.	Kw.	Volts. No load.	Volts. Full load.
1	250	500	545
2	250	500	552
3	440	500	550
4	1100	500	540
5	1500	500	550

It is desired that the station e.m.f. shall be 550 volts at full load. Of the above tabulated machines, one is above and two are below this value.

A simple test is necessary both to discover the series field current required to bring the e.m.f. of each machine to the prescribed voltage and to determine the resistance of the series coils, which also must be known. To make this test, one ammeter is put in circuit with the series field, another put in the main circuit, a high reading voltmeter connected across the negative brush and the outgoing terminal of the series winding, and a very low reading voltmeter is connected across the series winding. Fig. 4 shows the connections of these instruments. The machine is run at normal speed and loaded up to its normal capacity, as shown by the ammeter A_m. Adjust the shunt until the e.m.f., as shown by voltmeter, V_m, is 550 volts. Record the readings of A_f, A_m and V_f, V_m being in each case 550 volts.

Tabulating these readings on the above generators the following data are obtained:

TABLE II.

No.	Kw.	Amperes: Total.	Amperes: In field winding.	Amperes: In shunt strip.	V_f = volts across field.	R_f = field resist.
1	250	458	390	68	2.69	.0069
2	250	453	338	115	1.284	.0038
3	440	800	800	0	4.32	.0054
4	1100	2037	1905	132	1.065	.00056
5	1500	2710	1850	860	1.665	.0009

The value of the current through the shunt strip is found, of course, by subtracting that through the field winding from the total, and the resistance of the field winding is found by dividing the field drop, as shown by V_f, by the current, A_f.

Looking over the sixth column it is seen that the greatest drop at full load field current is that of machine No. 3, which is 4.32 volts. This must be the voltage between the equalizer and positive bus-bars as a lower e.m.f. would not pass the required current through the series field winding of this machine. This e.m.f., however, will be too high for the windings of the other generators, and resistances must be put in series with their series field windings to prevent excessive currents from flowing through them.

Going back to Table II and computing the resistance which would allow the proper current to flow through each field winding, as given in the table, with 4.32 volts impressed across it, the following values are obtained for R_m and R_s, in which R_m is the total resistance which the current will pass through under 4.32 volts impressed, and R_s is the external resistance to be inserted in series with the compound winding, this being, of course equal to the total resistance minus the field winding resistance.

TABLE III.

No.	Series field current; I_f	$R_m = \frac{4.32}{I_f}$	Series resistance; R_s
1	390	.01115	.00425
2	338	.01278	.00898
3	800	.0054	0
4	1905	.002275	.001715
5	1850	.00234	.00144

If an external resistance equal to that computed for any one machine be put in series with the compound winding of that machine, and all the dynamos be so equipped, the total output will be proportionately divided among the various machines at full load.

The total output of the station is the sum of the individual outputs in column 3, Table II, which is 6458 amperes, while the current required in the series fields is the sum of the currents in column 4 of the same table, or 5283 amperes. The difference between these two, or 1175 amperes, must pass through a shunt from the positive bus-bar to the equalizer. It makes no difference where along the length of the bus-bars this shunt is placed—if the bus-bars be not too small so that the drop along them will not be excessive. The resistance of this shunt must be

$$\frac{4.32}{1175} = .00368 \text{ ohm.}$$

The diagrammatic layout of the arrangement as computed, is shown in Fig. 5.

While this system will work perfectly, and each of the machines will take up its share of the full load, the I^2R loss in the series fields and the shunt is excessive. Assuming that the average station load is 25 per cent. of full load for six hours, 50 per cent. for six hours, 75 per cent. for eight hours, and 100 per cent. for four hours, the volts drop for each of these are 25 per cent., 50 per cent., 75 per cent. and 100 per cent. respectively, of 4.32, or 1.08, 2.16, 3.34 and 4.32 volts. The currents at each of these percentages of load are 1614, 3229, 4843 and 6458 amperes, respectively, and the total energy loss is therefore $6 \times 1.08 \times 1614 + 6 \times 2.16 \times 3229 + 8 \times 3.34 \times 4843 + 4.32 \times 6458 = 291.33$ kilowatt-hours per day. At 1 cent per kilowatt-hour this costs $2.91 1-3 per day or about $1060 per annum. Obviously, if the voltage drop between the positive and equalizer bus-bars be reduced, the energy loss, and consequently, the money wasted by it, will be proportionately decreased. Looking over Table II it is seen that the next lowest voltage drop is for machine No. 1, and is 2.69 volts. If all the dynamos were arranged to work with a voltage drop of 2.69 volts between the positive and the equalizer bus-bars the total energy loss per day would be

$$\frac{291.333 \times 2.69}{4.32} = 161 \text{ kilowatt-hours, and}$$

its annual cost at 1 cent would be $1.61 ×

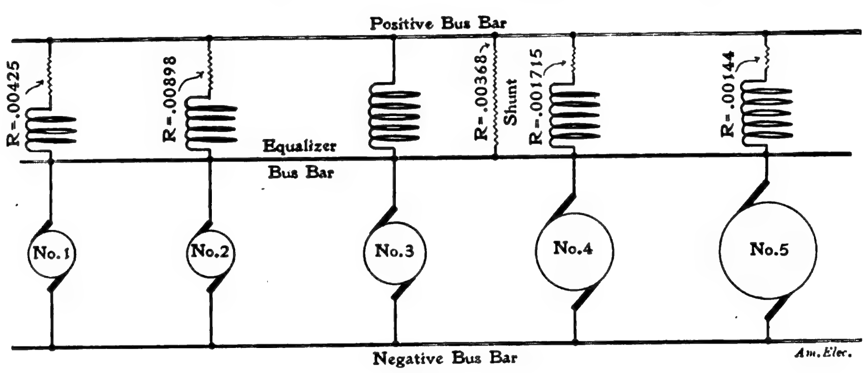


FIG. 5.

365 = \$588. The annual saving therefore—assuming that some alteration could be made in the 440-kw. machine—would be \$472, which is capitalization on about \$8000. Therefore, it would be better to sell dynamo No. 3 for whatever it would bring and purchase a new machine, rather than attempt to work it in parallel with the others if it cannot be so altered as to require a less voltage across its series fields at full load. This question is a commercial, not a technical one.

In all probability, however, it would be found that there is room on the field magnet poles to add more series winding. If so, it is only necessary to wind on another series coil over each existing one, the new and old coils having the same number of turns and connect the two in parallel. This produces an equivalent series coil of diminished resistance.

To determine the cross section of the conductor in the additional winding, assume a reasonable mean length of turn and find the ratio of this length to the mean length per turn of the existing winding; represent this ratio by r. Let b = voltage drop through the existing winding at full load, c = desired voltage drop through new and old windings in parallel, x = cross-section of new conductor, and a = cross-section of the old. Then $x = a \times r \dfrac{b-c}{c}$.

As an example, take the 800-kw. generator having a drop of 4.32 volts across the series field winding with 800 amperes flowing through it, and let it be required to wind on additional copper of such cross-section as to reduce the drop to 2.69 volts with same current and same effective turns. The cross-section of the series conductor on the machine is 600,000 cir. mils. The mean turn of the existing winding is 3.25 feet in length; assuming that of the additional winding will be 3.6 feet, the ratio, r, is $\dfrac{3.60}{3.25} = 1.11$; then $b = 4.32$, $c = 2.69$, and $a = 600{,}000$, and by the foregoing formula the cross-section of added conductor, $x = 600{,}000 \times 1.11 \times \dfrac{4.32 - 2.69}{2.69} =$ 403,596 circular mils. These two windings connected in parallel will give 2.69 volts drop when 800 amperes pass through them. Since this additional winding can be put on for a very small cost, it should be done if possible and the 440-kw. machine retained, unless its efficiency is too low. If 2.69 be adopted as the voltage drop between the positive and equalizer bus-bars, the resistances to be put in series with the series fiel windings of machines 2, 4 and 5 are computed as previously outlined.

Referring again to Table II it will be evident that the series field voltage of 2.69 suggested for adoption is that of machine No. 1, which is of only 250 kilowatts capacity—a small machine as compared with Nos. 4 and 5. Of dynamos Nos. 2, 4 and 5, the highest field drop is that of No. 5, which is 1.665 volts at full load. If this were adopted as the drop between the positive and equalizer bus-bars, a comparison of the field losses at this voltage and at 2.69 volts, on the basis already stated, would show \$225 annual saving for the lower voltage drop, and if the machines were of similar kind with like characteristics, it would pay to rewind both dynamos Nos. 1 and 3 to give a drop of 1.665 volts at full load and change the resistances inserted in the series fields of Nos. 2 and 4, and the shunt resistance, to suit this changed value; but in machines which differ as greatly as do these, the division of the load is not stable nor well defined unless there be an appreciable voltage drop between the equalizer and positive bus-bars, as the small drop in the bus-bars themselves becomes large as compared with the drop between them. In the present case, therefore, it would be best to adopt 2.69 volts as the drop between the positive and the equalizer bus-bars.

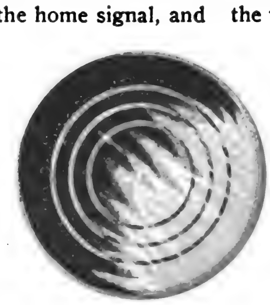
AUTOMATIC BLOCK SIGNALS.

BY RALPH SCOTT.

Complete Normal Clear Circuits.

In Fig. 62 the arrangement of a normal clear system, giving complete protection for a double track system, with another line crossing, is shown. The block between signal 7 and signal 8 is very long in this case. The reason for assuming such a long block is to prevent confusion in the circuits.

Describing the apparatus at signal 3, there is the signal battery *i*, connected to the home board through the contact armature *a*, of the relay *h*, and also connected to the distant board through the neutral armature *b*, and the polarized armature *c* of the track relay *e*. The track battery *f* is connected to the block *A* through the current reverser *g*, which is operated by the home board of this signal. The circuit closer *d* is operated by the home signal, and connected in series to the distant signal. By means of this circuit closer, when the home signal moves to danger, the distant signal circuit is also opened.



It is to be remembered in this diagram that *n* are the home signals and *o* the distant signals. At signals 13 and 9, the distant signal is omitted, not being necessary. A polarized track relay *p* has two neutral armatures, the upper one of which forms the indication armature.

In this diagram, crossing *D* is only partially connected, through its track relay, and the switching track *C* is not connected at all, the reason for this being to prevent unnecessary complication.

All the apparatus shown at 10 constitutes what is known as an interlocking tower, this apparatus being all included within the tower 11. The relays *l*, which form the means for electric locking, prevent any conflicting of the signals given out at this tower. In addition to these are the circuit closers *m*, the upper set of which are connected in series with the relay *k*, and some of the wires *P* to *Y*, which, if of sufficient length, are line wires.

These line wires effect the various interconnections between signals 13, 7, 9 and 8 and the interlocking system. *P* connects relay *p* to the track, *Q* connects the signal

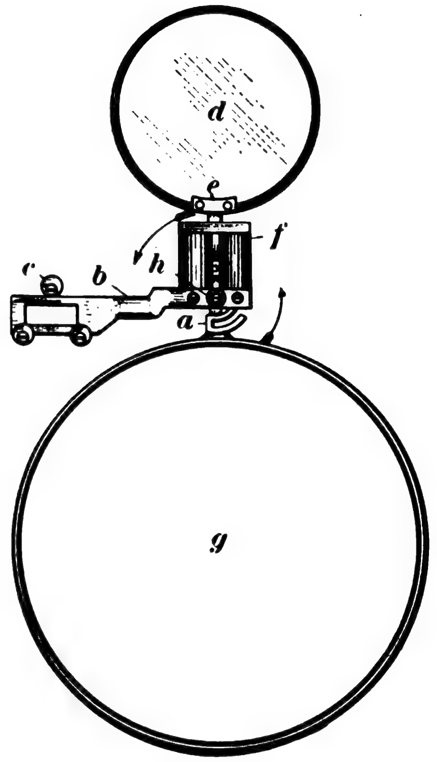


FIG. 63.

battery at 13 with the upper armature of the relay *X*; *R* and *S* form indication wires, while *T*, *U*, *V*, *W* and *Y* perform various functions. The line wire *u*, passing from the top armature of relay *q*, connects battery

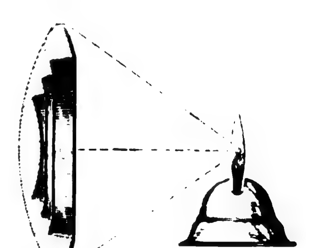


FIG. 64.

s with one side of the signal at 7, the other side of this battery being connected to the signal 7 through the relay at this section. The circuit closer, *r*, operated by the signal 8, opens or closes the circuit of a distantly located signal. The circuit closer *v* is in series with the locking contacts *m*.

From the normal clear circuits which have already been described, the reader may readily trace up and apply the circuits given on this diagram.

12 is a power plant, which is used in many systems. From this power plant line wires pass along the track and to the storage batteries at the various signals. These line wires are connected to the storage batteries through the medium of an electrically controlled or manually operated double throw switch. In many cases, such an arrangement is more economical than the use of primary batteries.

Disc Signal Mechanism.

The mechanism of the disc signal is shown in Fig. 63. The spectacle, *d*, of col-

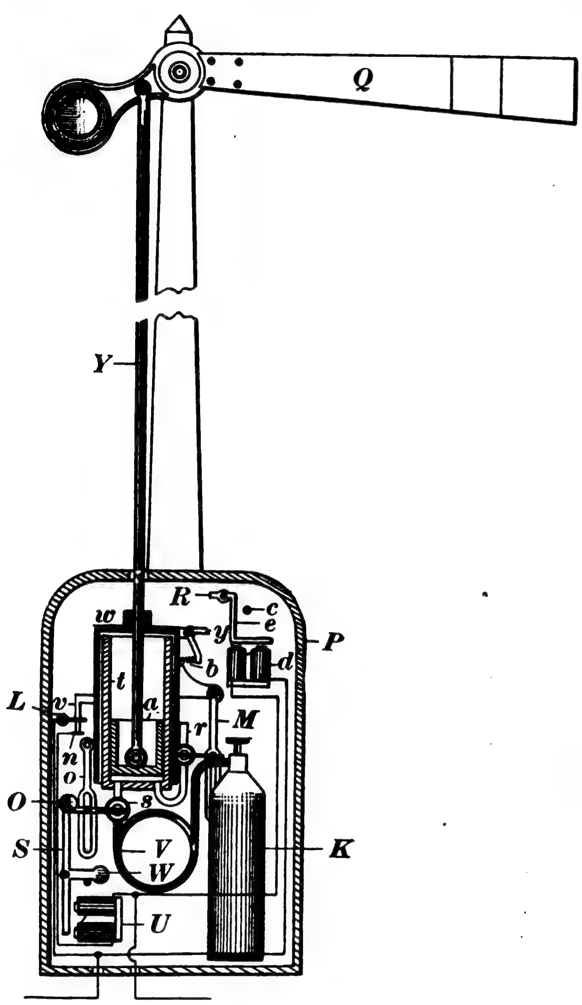


FIG. 65.

ored glass, used for night signaling, and the banner of colored cloth, *g*, used for day signaling, are both fastened to the armature, *a*, of the relay, *f*, by means of the clips, *e*. This armature is so arranged that the continuation of motion embraces a constantly increasing number of lines of force, so that the torque is much greater when the banner has moved to the clear position than at any other time. This is necessary, as the effect of gravity in opposing the torque of the electromagnet is zero in the position shown, and at a maximum when the disc has moved to the full clear position in the direction of the arrows. The armature is adjustably pivoted at *h* and supported by the brass member, *b*, held in place by the washers and screws, *c*.

A section and elevation of the spectacle of a signal is shown in Fig. 64, which also gives the focal distance at which the lamp is located. These lamps are constructed to burn continually for eight days, so that a minimum amount of care and attention are necessary.

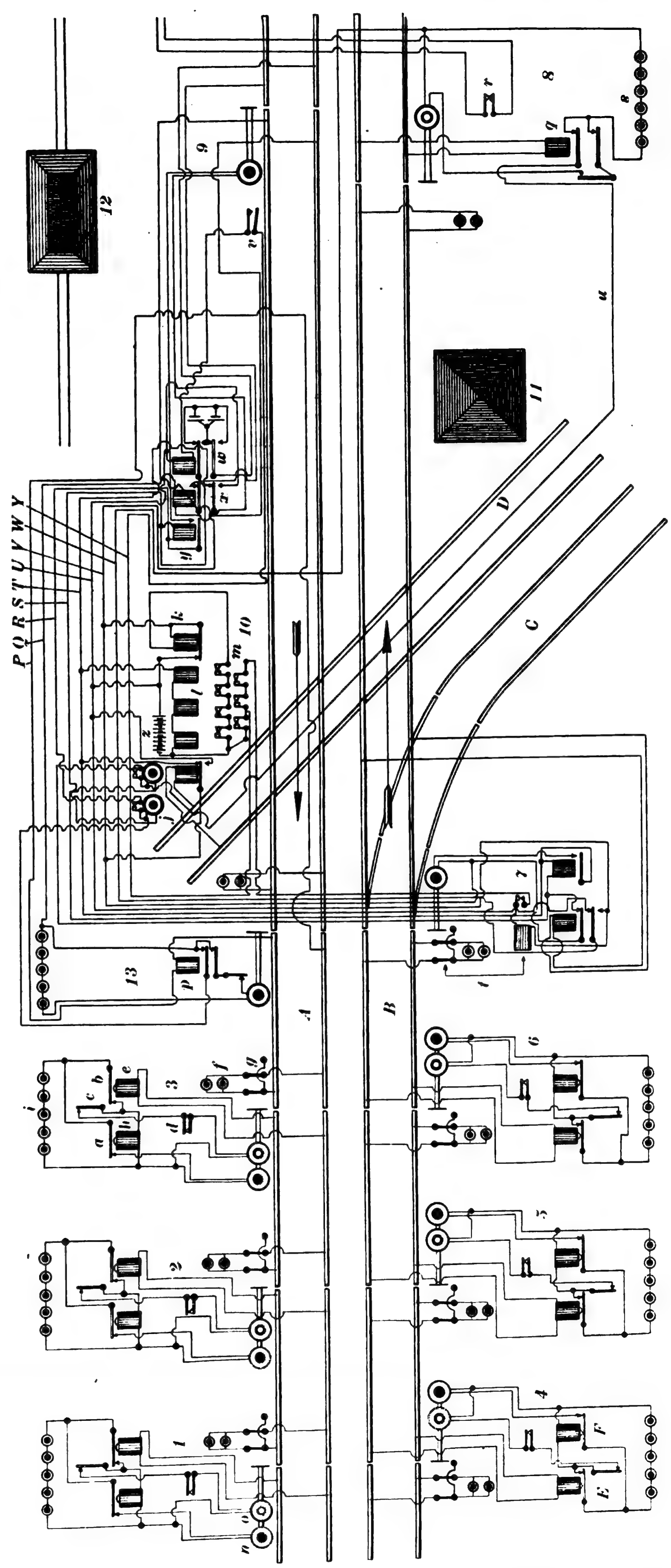


FIG. 62.—DIAGRAM OF CONNECTIONS FOR COMPLETE NORMAL CLEAR CIRCUITS.

The Electro-Gas Signal.

The earliest form of electro-gas signal is shown in part section and elevation in Fig. 65. The usual semaphore, *Q*, is operated by the movement of the rod, *U*. Fastened to this rod, within the housing, *P*,

placed at the base of the signal pole, is the casing, *w*, to which is fastened the circuit-closer, *v*, the pivoted catch, *y*, and the pieces *o* and *M* for shutting off the gas.

The gas flask, *K*, connected by the flexible pipe, *V*, to the valves *s*, contains the operating gas. Two relays, *d* and *u*, connected in multiple, are in the track or line wire circuit, a diagram of which is given later. The circuit of *U* is opened and closed at the pivoted spring contact at *L*, which tends to remain open, unless forced into contact with *n* by the projection on *v*. The contact at *L*, therefore, will be open except when *Q* is at the danger position, as shown.

The catch, *y*, is held in a state of resiliency by the spring *b*, which engages, when the signal is in the clear position, with the end, *R*, of the pivoted member, *e*, which latter is prevented from moving too far upward by the stop, *c*. *e* is held in its lower position by the electromagnet, *d*, which, when energized, and the signal has moved to the clear position, maintains the latter in that position, releasing it when the current ceases.

Relay *U*, by attracting the pivoted armature, *S*, weighted at *W*, allows the weighted handle, *O*, of the valve *s* to drop, thereby admitting gas to the cylinder, *t*. This causes the piston, *a*, to move upward and clear the signal. At the instant that motion commences, the circuit of *U* is broken at *L*, thus allowing *S* to move to its normal position. When *a* has nearly moved to its extreme upper position, the member, *o*, raises the valve lever, *o*, to its extreme upper position, thus shutting off the gas. At the same time, the exhaust valve at *r* is opened by the member, *M*, thus allowing the gas to escape from the cylinder. *a* is held in the clear position as long as the current passes through *d*, as explained above.

The exhaust valve is closed and the admission valve left normal on the return of the mechanism to the normal position, *O* being, therefore, in the position shown in the engraving.

Circuits.

The manner of connecting electro-gas single-mast signals with line wires is shown in Fig. 66. The signals, 1, 2 and 3, have their respective signal batteries, *A*, *B* and *C*, one side of which is connected to these signals. Relays 5, 6, 7, 8 and 9 at the cut sections, of the same number, effect the interconnections. The lower armature of relay 5 is connected to the signal, 1, and to the relay of cut section, 4, the upper armature being connected to the signal battery and the armature of the relay, 6. The lower armature thus serves to connect the battery to its signal, the upper armatures opening the circuit of the signal in whose block the relay occurs. Otherwise, the circuits are somewhat similar to those we have already considered under the normal danger system.

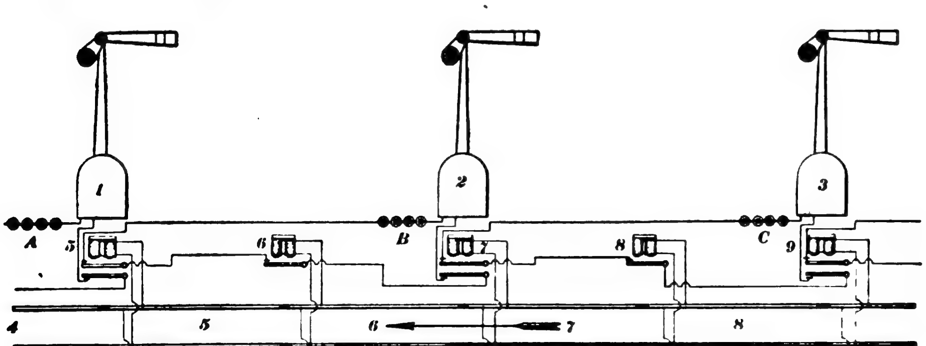


FIG. 66.

Abstracts from Foreign Contemporaries

New Method of Compensating and Compounding Alternators.—In a paper read before the Manchester Local Section of the British Institution of Electrical Engineers, Miles Walker describes a new compensating method for alternators, in which the field excitation is maintained constant and in which use is made of the armature reaction to strengthen the field on load. The illustration shows the arrangement of the generator field circuit. Each pole consists of at least two parts, a saturated part and an unsaturated part. The first is wound with a magnetising coil, and there may or may not be another magnetising coil placed around the whole pole. This second winding may be necessary for varying the normal voltage of the machine. The broad pole is very highly saturated in the region marked with shaded lines, while the narrow pole on the right is unsaturated, and at no load is unmagnetised. The field rotates counter-clockwise, and as the pole depicted in the figure is a south pole, it gives rise to an e.m.f. in the conductors above it, which is in the sense indicated by the crosses, that is to say, away from the observer. Any current in the armature which is in phase or nearly in phase ~~with this~~ e.m.f. will tend to demagnetise the saturated part of the pole and magnetise the unsaturated part. The flux from the saturated part cannot be changed to any great extent, while the unsaturated part becomes highly magnetised by armature reaction and increases the e.m.f. of the armature. The British Westinghouse Company has thoroughly tested this type of machine, and in all cases where the power-factor is not lower than 0.85 they find it possible to make a machine hold its voltage from no load to full load. In the great majority of cases in which alternate-current generators are used, the power-factor is higher than 0.85, so that a compound alternator without commutator or any complications can be supplied. The armature, in increasing the e.m.f., is instantaneous in its action. In cases where the power-factor ranges between 0.9 and 0.95, as in a great number of lighting stations, considerable over-compounding can be guaranteed. The following are the results of a test made on a 150-kw., three-phase generator, 415 to 440 volts, 25 periods, 500 r.p.m. The generator was belted to a shunt-wound, direct-current motor, and loaded on a rack of iron wire (power factor 0.97). With 28 amperes in the main field coils, and no current in the auxiliary field, the voltage was 416 at no load. On throwing on a load of 150-kw., and correcting the speed, the voltage rose to 445 volts, showing a compounding of 6 per cent. between no load and full load. On another test the main field current was diminished and the voltage brought up on the auxiliary field winding. The rise in voltage on load was not so great as before. By fixing the current in the two windings at a suitable figure, it was found possible to make the machine hold its voltage exactly between no load and full load. The generator was then loaded on a 100-kw. rotary converter through transformers. The rotary ran well in parallel, loaded and unloaded, at power-factors varying between unity and 0.7. The synchonising current could be reduced to a value too small to read upon the instruments by adjusting the field of the rotary. When the rotary was loaded so as to produce full load in the generator with unity power-factor, a rise in voltage of 10 per cent. was obtained between no load and full load. At a power-factor of 0.87 the voltage was maintained constant at

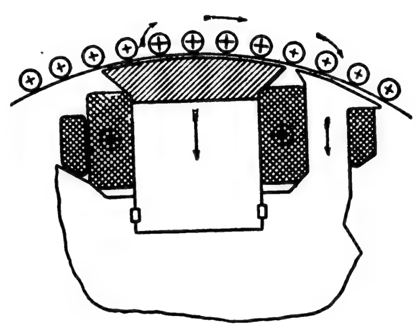


FIG. 1.—COMPENSATING AND COMPOUNDING ALTERNATORS.

all loads. The drawback to this method of compounding is that as the power-factor decreases the magnetising effect of the armature also decreases, but this objection is not so serious as might at first be supposed, for in the majority of cases the generator is carrying all day the greater part of its non-inductive load. Take the case, for instance, of a station supplying principally incandescent lamps. All day the generator has to supply the magnetising current to transformers, and when the load comes on suddenly in the evening the power-factor increases, so that a generator of the type described would have exactly the right kind of regulation. Similarly, where a generator is loaded with induction motors running light, a load on the motor increases the power-factor, and again the generator behaves well. In cases where sudden and large draughts of power at low power-factor are required, this type of generator would not be suitable. It may appear at first sight that a generator with a field magnet shaped as shown in the illustration would not have a good e.m.f. wave form. It has been found that by proper design the wave form at full load can be made to approximate very closely a sine wave; in fact, more closely than the wave form of the old simple type generator. At no load the wave form will not depart much from the true sine wave, but will have a slightly peaked form—the form, in fact, which has been found to be most economical with transformers working on light loads.

The Insulation of Armature or Other Coils for High-Tension Apparatus.—J. S. Highfield contributes to a recent number of the London *Electrician* an article relating to troubles experienced from time to time by the breakdown of the insulation of armature coils in alternators built for 6000 volts and upwards. In the case of most machines the copper is insulated from the core plates by means of a solid mica or micanite tube, having a dielectric strength capable of resisting at least four times the working pressure; and the ends of the tubes are carried out quite clear of the frame, so that there can be practically no chance of sparking taking place from the ends of the coils to the frame. Careful experiments were made to determine the exact cause of the trouble. The coils of one machine in question were insulated between turns with varnished cotton braiding, and without by the micanite tubes above mentioned, the micanite being of the best possible quality, and the tubes being exceedingly well built. The coils were formed by winding the ribbon, of which the conductors consist, through two tubes. The ends of the coils, where they emerge from the tubes, were protected by slips of mica and wrappings of the well-known ordinary Empire cloth with prespahn, and finally black-taped to give some mechanical protection, the workmanship being all that could be desired. Upon examining a coil, by splitting open the tube, it was at once apparent that serious corrosion had been taking place, the braiding being practically destroyed, and the copper covered with a green deposit. An inspection of the ends of the coils showed that the Empire cloth near the tubes was completely rotted, being quite damp and having a strong acid reaction, but the braiding was in fairly good order, although also damp and having acid reaction. Upon opening some of the tubes, it was discovered that, in some of the coils, the whole of the braiding was rotted away, the copper being covered with a green deposit, which, upon analysis, was found to be nitrate of copper; there also appeared to be a certain amount of free nitric acid present. In the Empire cloth, at the ends of the coils, sulphuric acid was found. As the materials were all of the best, it was immediately suspected that the nitric acid was formed by brush discharge causing ozonization of the air and in order to make quite sure of this fact, one of the tubes was carefully cleaned, and a strip of bright copper gauze covered with pure filter paper was placed inside the tube, the outside of the tube being covered with tin-foil connected to earth, the copper being connected to the supply of 10,000 volts—the paper was not specially dried. Ozone was produced in considerable quantities at once, and in about one week a considerable amount of green deposit of nitrate of copper was formed on the copper gauze, and free nitric acid on the filter paper. The cause of the breakdown of the coils was therefore quite clear. Brush discharge took place on the inside of the coils from the copper to the mica, and, with the nitrogen from the atmosphere and moisture from the air, produced nitric acid. The acid worked itself out of the tube, and, combining with the gympsum in the Empire cloth or braid, formed sulphuric acid at the ends of the coils. It was found that the coils at the end of the machine were in a worse condition than the ones lower down, and the degree of corrosion was somewhat variable, pointing to the fact that some of the coils were dryer than others, there being no doubt that the rate of corrosive action was enormously increased by the presence of free moisture. From researches made it would appear that in any machines, even down to as low a pressure as 2000 volts, trouble from the above mentioned cause might be experienced. Careful vacuum drying of the coils during the process of insulation would undoubtedly serve to delay the breakdown of the machine, but it certainly seems that no method of insulation admitting air between the copper, iron and insulation can produce a machine that will last for all time. The only proper method is to fill in the whole of the space from copper to iron with insulating material, so as to entirely exclude air. The mere sealing of the ends is not likely to be a remedy, as considerable heat is generated in the armature; this expands the air in the coils, and on cooling a slight vacuum is formed which encourages the entrance of fresh air bringing with it some quantity of moisture. The investigation showed the necessity of carefully insulating the last two or three coils at the end of the armature where the pressure is greatest. It was found that, on the last coil particularly, the copper was pitted in places, and opposite each little lump the braiding was punctured.

Cylindrical Water-Tube Boiler.—Fig. 2 herewith illustrates a Cummins vertical water-tube boiler, a description of which is given in a recent issue of *The Engineer*, of London. The boiler consists of an upper and lower drum, connected by straight vertical water tubes. The furnace is situated underneath the lower drum, which has a central flue, through which the gases pass to the combustion chamber. The combustion chamber is formed by the space between the upper and lower drums above this flue, which is, of course, free of water tubes. After leaving the combustion chamber the gases are compelled, by means of a curved baffle plate, to divide into two streams, each stream having to travel a long distance among the water tubes before passing away to the funnel. The water tubes are of comparatively large diameter, $2\frac{1}{2}$ ins., are straight, all of one length, and secured in the tube plates in the usual manner by expanding. The upper drum is made of sufficient height to allow the water

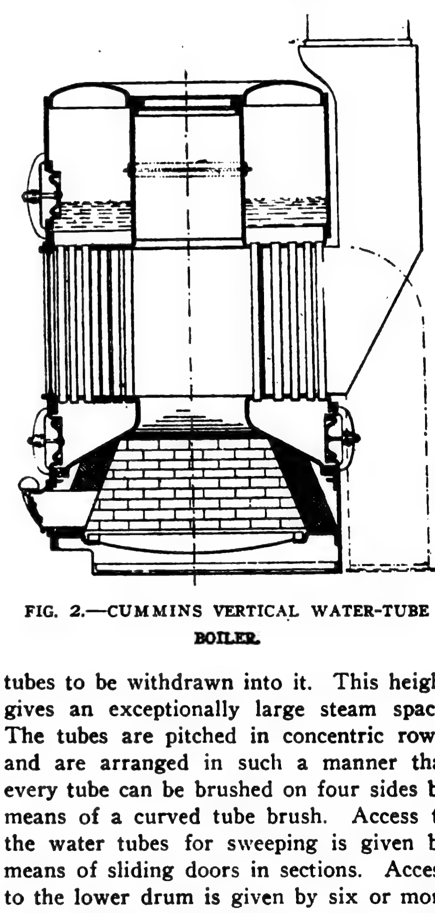


FIG. 2.—CUMMINS VERTICAL WATER-TUBE BOILER.

tubes to be withdrawn into it. This height gives an exceptionally large steam space. The tubes are pitched in concentric rows, and are arranged in such a manner that every tube can be brushed on four sides by means of a curved tube brush. Access to the water tubes for sweeping is given by means of sliding doors in sections. Access to the lower drum is given by six or more large manholes. The upper drum is made annular like the lower one, the central space being utilized for a superheater when such is required. The lower casting carrying the fire-bars is lined with fire-bricks. The volume of the combustion chamber has been arranged to be equal to that of a return-tube marine boiler of the same power. The combustion chamber is surrounded by water tubes, so that the intense radiant heat will be at once taken up by them. The furnace is lined with fire-brick, which is a great aid to good combustion. The fire-brick also protects the lower plate of the drum from

the direct heat of the fire. A fire-brick lining is also very essential for successfully burning liquid fuel. The furnace can be readily adapted for forced draught or mechanical stoking. The total distance traveled by the gases in this boiler is considerably more than in the case of a return-tube marine boiler. The water circulation in this boiler is quite positive, and, some of the tubes in the outer rows act as down-comers. In this boiler, by the removal of seven doors, the whole of the internal part of the boiler is perfectly accessible for examination, cleaning, or repairs. Complete access is given to both ends of the tubes, and any tube can be expanded, or cut out and renewed, without disturbing any of the others. All the internal landings of the joints can be re-caulked if necessary, and any tube can be plugged without emptying the boiler. In the same manner all the external landings of the riveted joints are accessible for re-caulking. The results of a test of a boiler of this description are given below:

PRELIMINARY TEST OF CYLINDRICAL WATER-TUBE BOILER (CUMMINS' PATENT.)

Conditions:—Lower drum not lagged, steam blown off at safety valve, cold feed, no superheater fitted.
Duration of trial: 6 hours.
Quality of fuel: Unscreened Welsh.
Class of firing: Hand.
Heating surface: 774 square feet.
Grate surface: 23.7 square feet.
Ratio: 1.32.
Steam pressure: 175 lbs.
Draught at base of funnel: 6 ins.
Temperature of feed: 60 deg. Fah.
Temperature of gases leaving boiler: 597 deg. Fah.
Temperature of steam leaving safety valve: 320 deg. Fah.
Corresponding superheat: 108 deg. Fah.
Fuel per hour: 448 lbs.
Fuel per square foot grate per hour: 19 lbs.
Fuel per square foot heating surface per hour: .58 lb.
Water per hour: 3,948 lbs.
Water evaporated per lb. fuel: 8.81 lbs.
Water evaporated per square foot heating surface: 5.13 lbs.
Water per lb. fuel from and at 212 deg. Fah.: 10.6 lbs.
Water per square foot heating surface from and at 212 deg. Fah.: 6.2 lbs.

During the trial the water level was maintained constant by the Fleuss automatic feed regulator. This apparatus controls the steam working the boiler feed pump, and has been in use on the above boiler for six months, during which time neither the boiler check valve nor the feed pump steam valve have been touched.

Patent Absorption Dynamometer.—A simple dynamometer is described in the London *Electrical Review*. It is especially suitable for measuring the brake-horse-power of electric and petroleum motors, and has a range of from ¼ to 20 horse-power. The power is absorbed by revolving vanes in air. Vanes of three different sizes are supplied, and the apparatus can be clamped on spindles from ¾ in. to 1⅜ in. diameter. The dynamometer is compact and simple, and goes into a box 24 in. by 9½ in. by 6 in.; the weight complete, including the box, is about 22 lbs. The essential feature of the dynamometer is the simplicity and quickness with which the brake-horse-power can be obtained. It has been calibrated for speeds up to 2000 r.p.m. The dynamometer is clamped on the spindle of the machine to be tested, and the vanes are adjusted to such a radial position that the motor runs at the required speed when under load. Knowing the speed, and the position and size of the vanes, the horse-power can be immediately obtained from the calibrated results which are supplied with the dynamometer.

Arc Lamp Suspension.—The London *Electrical Review* shows an extremely ingenious and simple form of hook for suspending an arc lamp, which was originally described in *Génie Civil*. The suspension rod of the lamp ends in a ball, *S*, which, when the lamp is in place, rests in the hook, *C*, as shown in Fig. 3. Upon hauling on the suspension rope, *A*, the ball slides along the under side of the inclined plane, *P*, and presses the hook, which is pivoted at *B*, to one side. When the ball passes through the enlargement at the top of the hook the latter swings forward

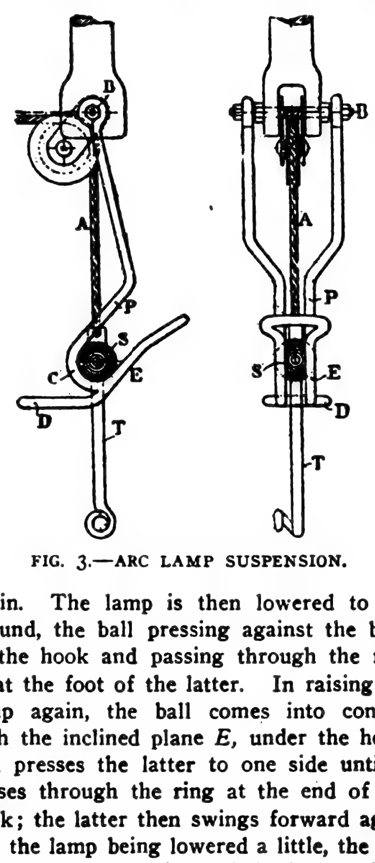


FIG. 3.—ARC LAMP SUSPENSION.

again. The lamp is then lowered to the ground, the ball pressing against the back of the hook and passing through the ring *D* at the foot of the latter. In raising the lamp again, the ball comes into contact with the inclined plane *E*, under the hook, and presses the latter to one side until it passes through the ring at the end of the hook; the latter then swings forward again and the lamp being lowered a little, the ball descends into the bight of the hook, where it is securely held. As the cord is always retained within the hook, it can never get out of place or be otherwise deranged.

Governor for Turbines.—A new method of governing turbines, has been installed in the hydraulic installation of Bournillon, a description of which appears in *Engineering*, of London. In this apparatus the essential feature is a pump, *P*, with a constant delivery, which compresses water into the chamber, *K*, and the system of piping, *m*, and can only escape into the tank, *A*, when the valve, *S*, is raised. The area of valve opening is regulated by a centrifugal governor. It is evident that for every position of the valve there is a corresponding pressure, *h*, in the compression chamber of the pump, and it is given at each instant by the relation $Q = k\,S\,\sqrt{2\,g\,h}$. Where *Q* is the quantity of water delivered by the pump, *k* is a coefficient of contraction, and *S* is the section of the orifice at the moment of consideration. As the velocity of the governor increases, the orifice is gradually diminished, and when closed

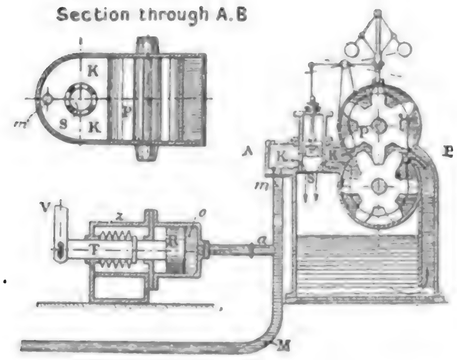


FIG. 4.—TURBINE GOVERNOR.

the water cannot escape into the chamber, and is therefore forced through the pipe, *m*, the pressure increasing until the speed again becomes steady; the valve then opens slightly, and the pressure at the delivery of the pump ceases to rise. At this moment there is a definite pressure corresponding to the position of the valve. It is obvious that the pressure created in the compression chamber is exercised on the piston, *R*, and since the force exerted on the latter is counterbalanced by the spring, *Z*, which compresses in proportion to the load it supports, it becomes evident that the piston occupies a certain position for each valve of the pressure, *h*, of the compressed liquid. Hence it follows that for every position of the governor there is a corresponding pressure of the liquid and position of the piston, both positively determined. The piston is connected by levers, *T* and *V*, in a rigid manner with the regulating mechanism of the turbine, and there can therefore be only one possible position for the sluice valve at any moment for a given position of the governor. Supposing that a motor turning at a uniform angular velocity, V_0, is unloaded abruptly, then the speed instantly commences to increase, and would take a working speed, V_1, if there was no governor. But in this case the latter rises when the velocity increases, and consequently the valve, *S*, closes, causing the pressure, *h*, to increase, and the springs to compress, thus moving the piston-rod, *T*, and shutting the sluice valve of the turbine. This action of the valve ceases immediately the couple of the motor becomes equal to the couple of resistance; in other words, all is again in equilibrium at a new angular velocity, V_2, which is a little higher than the initial velocity, V_0. If, on the other hand, the load is applied suddenly, then exactly the reverse of this operation takes place. It will be seen that everything acts as if the sluice valve was controlled directly by the governor. The governor can be so designed as to give the valve a quick action and further, it is possible to make it such that the speed variation, $V_2 - V_1$, can be made as small as desired. By means of a simple arrangement V_2 can be reduced to the initial velocity V_0 when it is necessary to keep the speed quite constant, however much the load on the motor may fluctuate. The governor can be worked by hydraulic power when there is a sufficient fall of

water, otherwise the water under pressure must be supplied from an accumulator, the necessary pressure being obtained by means of pumps, or the method illustrated in the diagram may be employed.

The Tantalum Incandescent Lamp. — In a paper read recently before the Elektrotechnische Verein at Berlin, Drs. W. von Bolton and O. Feuerlein describe the new tantalum lamp made by Siemens & Halske. After experimenting for a number of years in the metal tantalum itself and also on the shape and size of lamp the form shown by Fig. 5 herewith was finally arrived at. This shows a 110-volt, 25-c.p. lamp using 1.5 volts per Hefner candle-power. In this form, differing from most of the previous constructions, the central support consists of a short glass rod carrying two lenses into which the arms, bent upward and downward in the shape of an umbrella, are cast. The upper star has 11, the lower

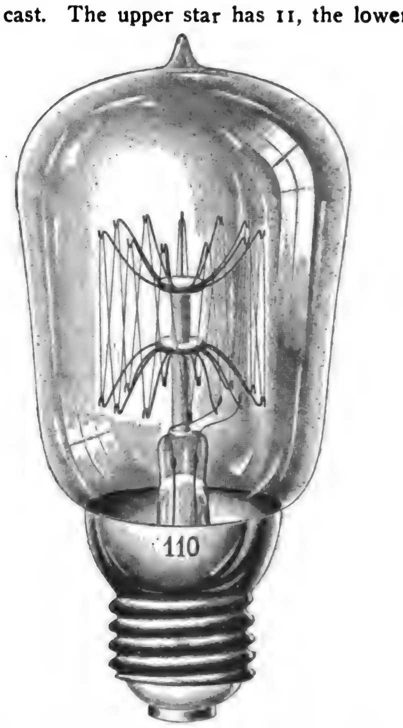


FIG. 5.—TANTALUM INCANDESCENT LAMP.

12 arms, each upper arm being in a vertical plane midway between the vertical planes in which two adjacent lower arms lie. Between these arms, which are bent into hooks at their ends, the entire length of the filament is drawn zigzag. Its extremities, held by two of the lower arms, are connected with the foot of the lamp by means of platinum strips. The standard type for 110 volts, 25 Hefner candle-power, and 1.5 volts per candle-power, has a filament 650 mm. long and 0.05 mm. in diameter. The weight of this filament is 0.022 grams, so that about 45,000 lamps contain together 1 kilogram of tantalum. The shape of the glass globe is adapted to the frame described above. Care has been taken to make it of a size not exceeding the usual maximum dimensions of common incandescent lamps of the same candle-power. This shape offers a number of noticeable advantages. In the first instance it is very stable, and will stand severe shocks without damage to the lamp. A considerable number of such lamps were sent across the sea to test their resistance to the hardships of transport, and came back unhurt, although they had been packed just like common incandescent lamps, and no special care had been taken at any time in their handling. The lamp burns, of course, in any position, and can therefore be held in any kind of fitting. The light is white and agreeable; its effect is particularly steady if the lamps are provided with ground glass globes. Numerous trials for lengthy periods of time, at rates varying within the range of 1 to 3 watts per candle-power, have proved the vast superiority of the tantalum lamp over the carbon filament lamp under equal electric and photometric conditions. Expressing this fact in figures, the authors state that the tantalum lamp consumes about 50 per cent. less current at the same voltage, with the same intensity of light and the same useful life, than the carbon lamp does, or that it supplies about double the light of the carbon lamp with the same consumption of current; while at the same economy the life of the tantalum lamp is several times that of the carbon type. Moreover, at an initial load of 1.5 volts per Hefner candle-power the tantalum lamp has an average life quite sufficient for all practical requirements, so that this rate of consumption has been standardized for the 110-volt lamp. Trials at a load of 1 watt per Hefner candle-power also proved that the lamps had periods of life of several hundred hours, but in that case the lamps were very sensitive to variations of pressure, and often showed an early decrease of illuminating value. The *useful life* of the tantalum lamp—*i.e.*, the life within which it loses 20 per cent. of its initial illuminating value—averages between 400 and 600 hours at 1.5 watts per Hefner candle-power; some specimens have proved to have a *useful* life of more than 1200 hours. The *absolute* life amounts to an average of 800—1000 hours under normal working conditions. Further, the tantalum lamp blackens but little, unless it has been strongly overheated during work in consequence of partial short-circuiting of the filament. It is very interesting to observe the behavior of the tantalum lamp during the whole course of its life. The first fact worthy of note is that, like some carbon lamps, the illuminating value increases at the beginning, generally after a few hours, by 15 to 20 per cent. In the same way the consumption of current rises by about 3 to 6 per cent., while the consumption of power drops to 1.3 to 1.4 watts per candle-power. After that, the illuminating value gradually decreases, while a corresponding increase of the consumption of power occurs. The average behavior of the 25-c.p. lamp at 110 volts, with reference to its various periods of life is shown in the accompanying table.

Life hours.	Intensity of light Hefner c. p.	Consumption in amperes.	Watts per Hefner c.p.
0	25—27	0.36—0.38	1.5—1.7
5	28—31	0.37—0.39	1.3—1.5
150	25—27	0.36—0.38	1.5—1.6
300	22—24	0.36—0.38	1.6—1.7
500	20—22	0.36—0.38	1.9—2.0
1000	18—20	0.35—0.37	2.1—2.2

The initial increase of illuminating value and of current consumed, is, doubtless, caused by a change in the structure of the tantalum wire, this change being accompanied by a reduction of resistance, and, consequently, of the phenomena resulting therefrom.

Measurement of Vacuum.—The London *Electrical Review* contains an abstract of a paper delivered by C. Turnbull at Newcastle, on the measurement of vacuum. The vacuum gauge in common use measures the difference between the condenser pressure and the atmospheric pressure. It is, therefore, necessary to read the barometer as well as the vacuum gauge to get at the true result. What is required is an instrument which will fulfil the following

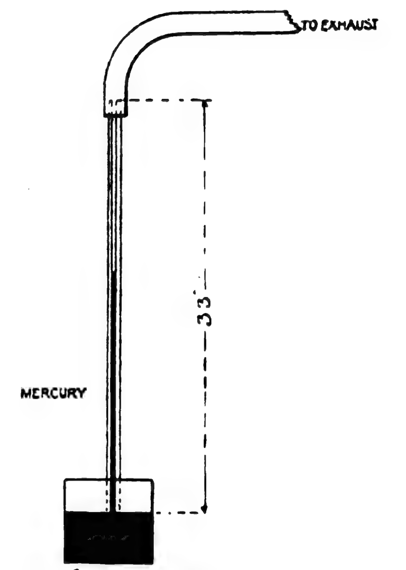


FIG. 6.—MEASUREMENT OF VACUUM.

conditions: (1) It must show the actual pressure in the condenser quite independently of the pressure of the atmosphere; (2) It must be quite accurate in its readings, and not liable to go wrong. The first requirement would be met by an ordinary Bourdon gauge with an exhausted tube (or a similar arrangement to that used in the aneroid barometer), but with the case of the instrument connected to the condenser. This will measure the actual pressure at the exhaust, quite independently of the pressure of the atmosphere. Another and perhaps better way is to make use of the ordinary mercury barometer, only it must be connected up properly. As ordinarily used (Fig. 6) the mercury column balances the difference between the condenser pressure and that of the atmosphere. If it is connected, as in Fig. 7, the mercury column will show simply the actual pressure in the condenser, and quite accurately. When the mercury rises 4 in. in the tube, it

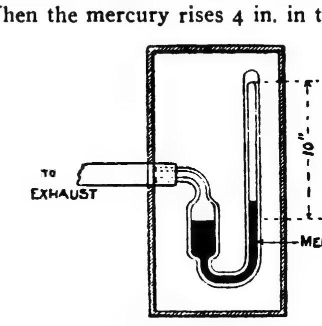


FIG. 7.—MEASUREMENT OF VACUUM.

means that there is a pressure in the condenser which has an effect upon the back of the piston of a reciprocating engine as if the piston were lifting a layer of mercury 4 in. deep. For most purposes with the in-

strument, as in Fig. 7, a 10-in. tube is quite long enough, for this will show a vacuum as low as 20 in. It is to be noted that the reading of any vacuum gauge is materially altered by its position. If it be placed low down, then water will collect in the tube leading to it and the weight of the column of water will affect the reading. Probably this fact often accounts for the difference of reading between the gauge on the engine exhaust pipe and the gauge on the condenser, as much as the drop of pressure between the two due to loss in the connecting pipes.

FAN MOTORS FOR 1905

American fan motors have become so thoroughly standardized that but few changes have been made this year, and extremely few really new machines have been brought out. The construction of the unchanged machines has been described so often and so thoroughly before that it is deemed inadvisable to do more in the present article than to give brief descriptions of

FIG. 1.—G. E. COMMUTATOR TYPE, ALTERNATING-CURRENT FAN MOTOR.

new fans, and point out improvements in the old ones.

The General Electric Company has brought out only one new fan-motor this

FIG. 2.—G. E. COMMUTATOR TYPE ALTERNATING-CURRENT FAN MOTOR DISASSEMBLED.

year, but its line has been extensively revised and improved. The new machine is a commutator alternating-current motor, similar in appearance to the well-known G. E. direct-current fan-motor. Fig. 1 shows the machine in perspective, and Fig. 2 is a view of its disassembled component parts. The field magnet is, of course, built up of steel laminations, and these are mounted in

FIG. 3.—G. E. INDUCTION ALTERNATING-CURRENT DESK FAN MOTOR.

a cast-iron housing. The magnet is bipolar and is provided with two machine-wound and individually-insulated coils, as indicated in Fig. 2. The armature is of the slotted drum type, machine-wound, and provided with the ordinary direct-current commutator. The insulation of both armature and commutator is of the same quality as that used in the standard dynamos and motors of larger sizes. The brushes are of carbon, of rectangular cross-section, and they are fed through box-holders by pivoted fingers and helical springs. The holders are mounted on a ring of insulating material, as shown in the foreground of Fig. 2, and this ring is screwed to bosses on the inner side of the journal bracket or yoke. This journal bracket is independent of the enclosing end-cap of the machine; the latter is of thin metal and is held in place by two screws. Consequently, the machine may be exposed for inspection and adjustment in its running condition, or while in operation. The bearings are lubricated by means of the familiar under-feed cups.

This machine is built for operation on either 25-cycle or 40-cycle circuits at 110 volts. The fan is 12 in. in diameter, and the motor drives it at full speed with 90 watts at 25 cycles or 94 watts at 40 cycles. The full speeds are 1700 and 1900 r.p.m., respectively, at the frequencies named. The motor is equipped with a six-point speed-regulating switch. Either the swivel and

FIG. 4.—G. E. INDUCTION ALTERNATING-CURRENT BRACKET FAN MOTOR.

trunnion mounting shown in Fig. 1 or the rigid mounting shown in Fig. 2 is furnished.

The company also makes the line of induction fan-motors for circuits of 60 cycles and higher frequencies which was described in our annual fan-motor article last year. These are built with 12-inch fans with either swivel or swivel and trunnion mounting, for desk service, and 12-inch and 16-inch fans with swivel and trunnion mounting in desk and bracket types. An 8-inch fan, with special suspension for telephone booths, is also built. The casings of the desk and bracket motors have been improved in appearance since last year, as reference to Figs. 3 and 4 will indicate, and six-point regulating switches have been substituted for the three-point switches used heretofore. The speeds and power values are as follows: 12-inch fans at 60 cycles, 1500 r.p.m. and 78 watts; at 125 cycles 1470 r.p.m. and 84 watts. The 16-

FIG. 5.—G. E. DIRECT-CURRENT FAN MOTOR.

inch fans at 60 cycles, 1570 r.p.m., and 178 watts; at 125 cycles, 1390 r.p.m. and 178 watts.

Fig. 5 illustrates the General Electric direct-current fan-motor for the present season. The field magnet is not laminated, as

heretofore, but is a single casting of extra soft iron. The field-magnet coils are wound in bobbins and subjected to the usual rigorous insulating and baking processes. The coils are held in place by means of spring bows, as shown in Fig. 6. The armature, Fig. 7, requires no description. The brush mounting partially shown in Fig. 5, is very similar to that of the new alternating-current machine already described, the brushes being fed in boxes by spring-actuated fingers and the boxes being mounted on a support of insulating material screwed to the journal bracket. As in the case of the

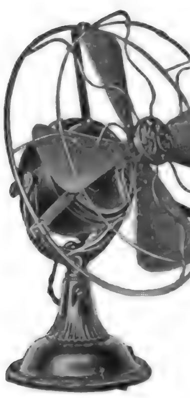


FIG. 8.—G. E. DIRECT-CURRENT DESK FAN MOTOR.

alternating-current fan also, the enclosing end-caps are of thin metal, removable with-

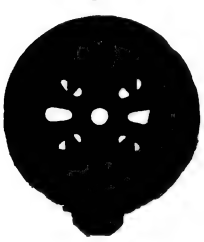


FIG. 6.

FIG. 7.

out disturbing the working parts of the machine.

The 12-inch fans run at 900 r.p.m. with 38 watts, 1200 r.p.m. with 45 watts and 1500 r.p.m. with 60 watts. The 16-inch fans run at 900 r.p.m. with 65 watts, 1200 r.p.m. with 85 watts, and 1500 r.p.m. with 100 watts. Both sizes are built with swivel and trunnion mounting in the desk and bracket

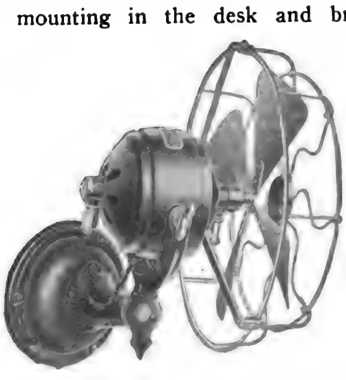


FIG. 9.—G. E. DIRECT-CURRENT BRACKET FAN MOTOR.

types, and the 12-inch fan is also built with rigid pedestal mounting All are made for either 115 or 230 volts. Figs 8 and 9 illustrate the pedestal and bracket mountings with swivel and trunnion. A direct-current motor is also built for telephone booth service. This machine has an 8-inch fan and runs at 1200 r.p.m. It is made for operation directly on a 115-volt circuit or in series with a 110-volt, 16-c.p., 55-watt incandescent lamp on a 115-volt circuit.

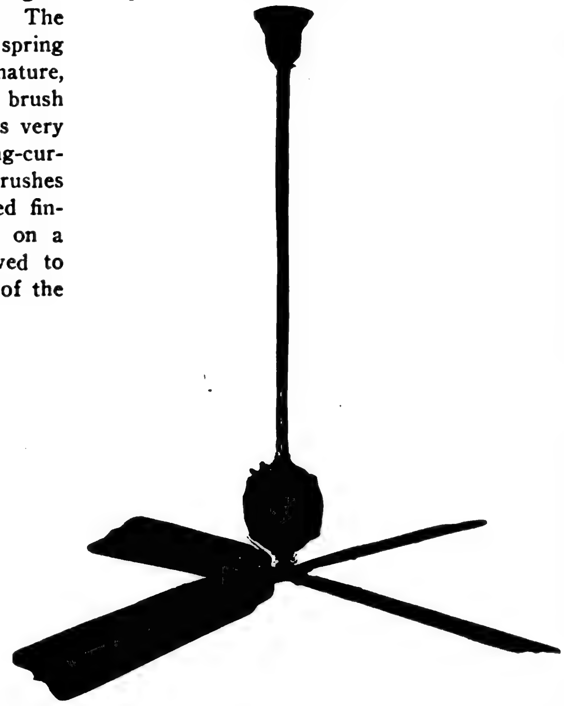


FIG. 10.—G. E. DIRECT-CURRENT CEILING FAN MOTOR.

The General Electric Company also continues its well-known line of three-speed ceiling fan motors for direct-current circuits of 115 or 230 volts, and the "Radial" fan-motor brought out two years ago. The ceiling fan line has been enlarged, however, to the extent of a single-speed machine with a 56-inch sweep running at 200 r.p.m. This motor is illustrated by Fig. 10. It is wound for either 115 or 230 volts.

The Dayton Fan & Motor Company, Dayton, Ohio, has added to its line the new "Dayton" fan-motor shown by Fig. 11, and discontinued the fan of the same name previously manufactured. The new machine has a bipolar field magnet and a Gramme ring armature, somewhat similar in construction to the arrangement used hitherto. The field winding is in two sections, wound directly on the magnet core, which is, of course, previously insulated. The commutator is of the conventional drum type instead of the disc form previously used, and it is located in a much more accessible position than heretofore. The speed-controlling resistance is located beneath the fan in an open case, so that the breeze from the blades vastly enhances the ventilation. Fig. 12 illustrates the electrolier form of this fan.

The Dayton Company is continuing the excellent line of desk and bracket fan-motors and the "Original Dayton" and "Dayton Junior" ceiling fans previously manufactured. The desk fans are built in 12-inch and 16-inch sizes, with rigid mounting or swivel and trunnion. The bracket motors are built only with swivel and trunnion mounting. All are wound for either 110 or 220 volts direct current.

The Diehl Manufacturing Company, Elizabethport, N. J., has added to its line of desk and ceiling fans a new "No. 44" ceiling fan illustrated in Fig. 13. The motor has a bipolar field magnet of cast iron, cast in a single piece, and a slotted drum-wound armature. The armature slots are insulated with micanite troughs before the winding is put on. The coils are machine-wound directly into the slots. The casing of the motor is ornamental filagree work at the top and bottom, with a belt of sheet metal heavily japanned and striped in gilt. The Nos. 28 and 45 fans of previous years have been discontinued; the line is otherwise unchanged.

FIG. 11.—"DAYTON" DIRECT-CURRENT CEILING FAN MOTOR.

The well-known line of alternating-current fan-motors built by the Emerson Electric Manufacturing Company, St. Louis, Mo., has been augmented by a "residence-type" induction-type machine of the same general construction as the "Trojan" line which was brought out last year. Fig. 14 shows the general appearance of the new machine. The field magnet, or stator, has six poles, and the speeds of the machine are thereby reduced to 1100 r.p.m. and 900 r.p.m., the lower speed being obtained by means of a switch and reactance coil. The motor is intended for 60 cycles only, and is made only in the 12-inch size. The power required is 75 watts at full speed and 55 watts at the lower speed. Swivel and trunnion mounting is employed, and in either the pedestal or the bracket form. The Emerson Company continues the manufacture of all of its excellent Emerson and Trojan desk and ceiling fans, which were described and illustrated in last year's article. These, it may be remembered, comprise 12-inch and 16-inch desk and bracket fans for 60 or 133 cycles, and the standard voltages, with swivel and trunnion mounting; two-blade and four-blade ceiling fans of the usual speeds for 60-cycle circuits, in both the standard Emerson and Trojan types, and a high-speed five-blade Emerson ceiling fan for 133 or 60 cycles. The Emerson ventilating fan outfits for both direct and alternating current are also continued this year.

FIG. 12.—DAYTON CEILING FAN MOTOR.

FIG. 13.—DIEHL CEILING FAN MOTOR.

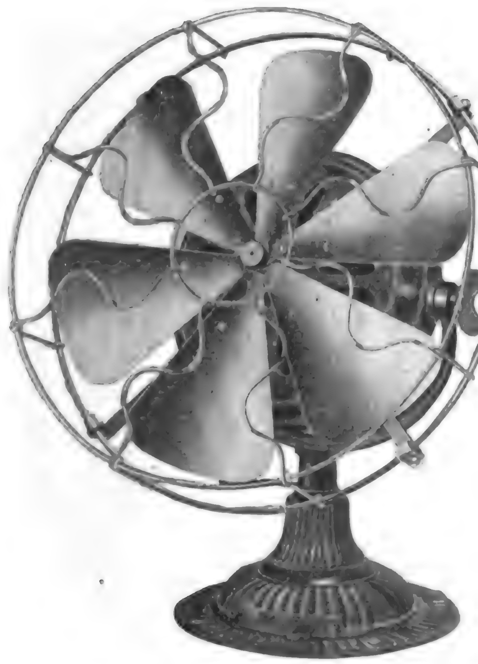


FIG. 14.—EMERSON ALTERNATING-CURRENT RESIDENCE-TYPE INDUCTION FAN MOTOR.

Fidelity Electric Company, Lancaster, Pa., has brought out a new alternating-current fan-motor this year. It is a simple series-wound commutator motor, with a bipolar field-magnet (laminated, of course), and a slotted drum armature. The commutator is insulated with mica throughout, and the insulation in other parts of the machine is of correspondingly high quality. The case is of aluminum, and the complete machine, with its 8-inch fan, weighs only 28 ounces. The motor is mounted on a combination pedestal convertible into a bracket, as shown in Figs. 15 and 16, or arranged for suspension from a lamp socket, as shown in Fig. 17. It runs at 1800 r.p.m. and requires 15 watts at that speed. The company also continues the entire line of direct-current desk, bracket and ceiling fans heretofore manufactured. These were described in our articles of March, 1903 and 1904.

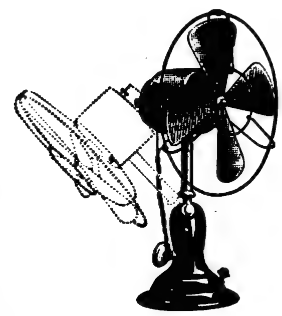


FIG. 15.—FIDELITY DESK FAN MOTOR.

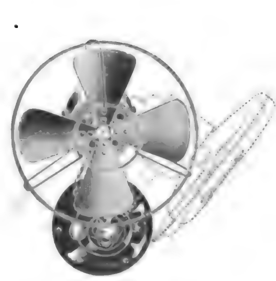


FIG. 16.—FIDELITY BRACKET FAN MOTOR.

Fort Wayne Electric Works, Ft. Wayne, Ind., has not added any new motors to its very complete line of direct and alternating-current machines, but the motors have undergone considerable improvement in constructural details, and a 12-inch size, with bracket mounting, has been added. The standard line has 8-inch fans. The conductors leading down the suspension cord of the hanging type of fan have been improved so as to eliminate the possibility of chafing and breaking. The bearings have been changed so that they are self-aligning. The automatic felt oilers have been retained. The brushes are carbon pencils of square cross-section fed in cartridge holders by helical springs, as indicated in Fig. 18, but they differ from the usual type in having a flat spring on the side of each brush which presses it into intimate and positive contact with the holder, and also prevents noisy operation due to chattering. As heretofore, the "Wood" fan-motors are built for 115 volts direct current, and for 52 or 100-115 volts alternating current, either 60 or 140 cycles. The three mountings—desk, bracket and suspension—are as before. The telephone booth fan-motor described last year is also built this season.

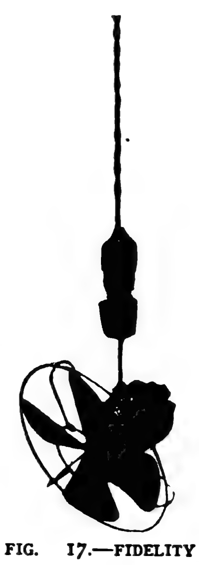


FIG. 17.—FIDELITY SUSPENSION FAN MOTOR.

FIG. 18.—FT. WAYNE BRUSH HOLDER.

The Peerless Electric Company, Warren, Ohio, has made no changes in the internal construction of its well-known line of desk, bracket and ceiling fan-motors. The frames of the desk and bracket types, however, have been much improved in appearance. A

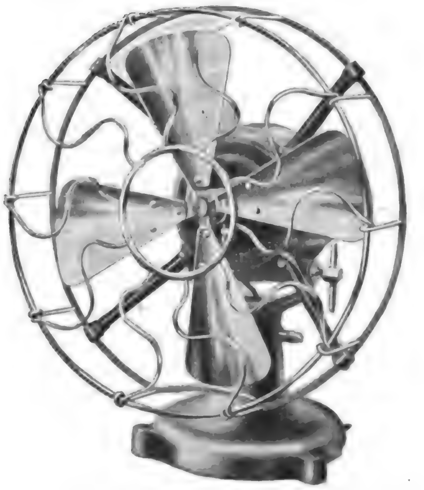


FIG. 19.—PEERLESS DESK FAN.

handsome smooth-finished pedestal and motor casing have been substituted for the fluted and ribbed exteriors previously used, and the difference will be appreciated by comparing Figs. 19 and 21 with Figs 53 and 54 of last year's article. A rigidly-mounted desk fan has been added also. The details of construction are the same as last year, with the exception of the mounting. These machines are built for the usual voltages, and the Peerless ceiling and column fans for standard direct-current voltages are again manufactured. A new oscillating fan-motor has been perfected for this season's market, but unfortunately the details of construction are not yet available. We hope to describe this machine next month.

Shedd Electric Company, New York, continues the manufacture of its "Comfort" oscillating fan-motor this year, and has brought out a new "Universal" machine, which is illustrated by Figs. 22 and 23. Fig.

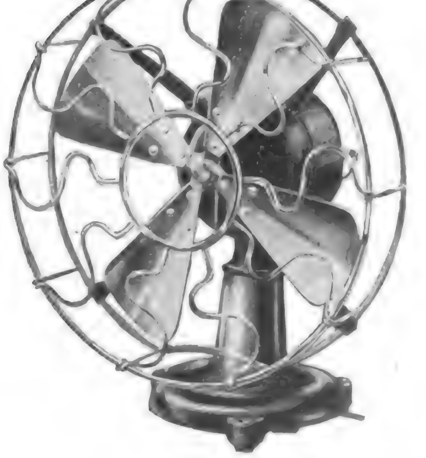


FIG. 20.—PEERLESS RIGID-PEDESTAL DESK FAN.

24 is a view of the frame with the armature and one end-cap removed. The field-magnet is cast in a single piece with holes, at each end of its axis, bored out to the same diameter as the pole-faces. The magnet coils are form-wound and heavily insulated before being put in place; the armature is of the usual slotted drum type. The brushes are square carbon pencils, and are fed to the commutator in box holders by helical springs. The holders are so con-

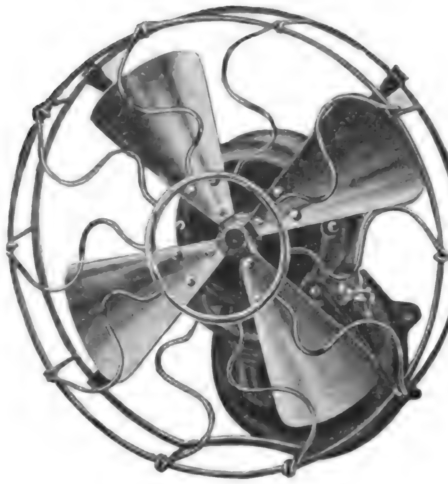


FIG. 21.—PEERLESS BRACKET FAN.

structed that a brush may be removed by merely pushing it back far enough to clear two ribs which normally hold it in the box. The machine is changed from pedestal to bracket form by loosening a set screw in the top of the pedestal, adjusting the motor body to the desired position and resetting the screw. The bearings are in the end-caps, and are lubricated either by underfeed wick oilers or by the top-feed grease cups shown in the engravings. The machine runs at 1000, 1400 or 1700 r.p.m., being equipped with a rheostat and switch to regulate the speed. It is built for the standard direct-current voltages in both 12-inch

FIG. 24.—SHEDD FRAME AND ARMATURE.

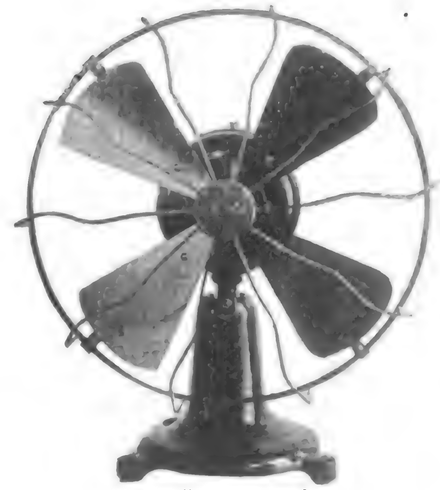


FIG. 22.—SHEDD "UNIVERSAL" FAN MOTOR.

and 16-inch sizes, and for 60-cycle alternating current of standard voltage in the 12-inch size only.

The Westinghouse Electric & Manufacturing Company has brought out a complete new line of desk, bracket and ceiling fan-motors for direct and alternating currents, the constructional details of which are not yet available. Figs. 25 and 26 illustrate the desk and bracket forms and show that the mounting is the swivel and trunnion type. The desk mounting is changed to bracket form by the insertion of a small adapter between the top of the pedestal and the motor

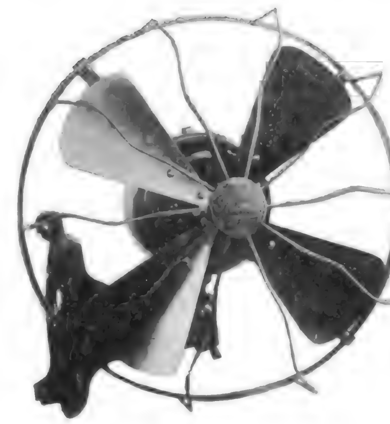


FIG. 23.—SHEDD "UNIVERSAL" FAN MOTOR.

body. The switch handle projects through a slot in the pedestal base as shown in Fig. 26. The direct-current machines run at 1000, 1300 and 1650 r.p.m. the 12-inch alternating-current fans run at 1300 and 1650 r.p.m., and the 16-inch fans at 1650 r.p.m. The fan blades are slightly dished, this form being claimed to give better air displacement than the flat type.

Jones Fan & Motor Company, New York, has brought out a new battery fan, which is illustrated by Figs. 27 and 28, and is known as the Perfection fan-motor. The field-magnet is of the familiar single-coil bipolar type, and the armature is of the polar type with three poles and coils; the armature core is laminated and the winding is protected at the ends by circular shields of insulating material, as indicated in the rear view, Fig. 28. The commutator is round and turned true with the shaft; the brushes are of copper gauze. The bearings are well lubricated by oil cups—not provided with

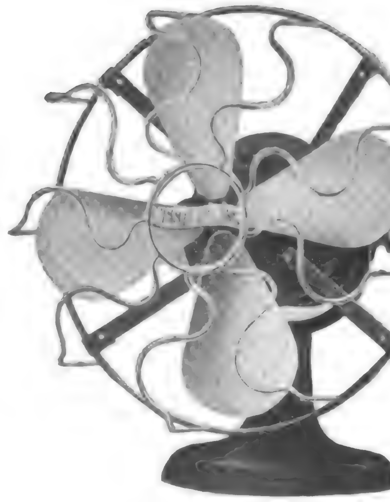


FIG. 25.—WESTINGHOUSE DESK FAN MOTOR.

mere holes through which a drop or two of oil can be administered. The fan is 10 inches in diameter, and the motor drives it at 950 r.p.m. when supplied with current at 6 volts, and takes 0.8 ampere at that speed.

Kendrick & Davis, Lebanon, N. H., have also brought out a new battery fan-motor

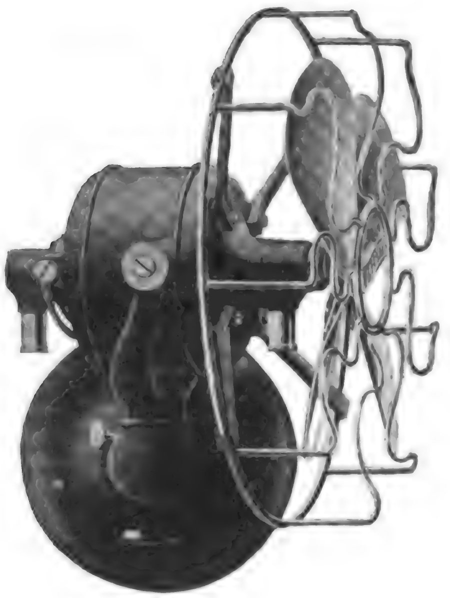


FIG. 26.—WESTINGHOUSE BRACKET FAN MOTOR.

this season. Fig. 29 shows the complete machine and Fig. 30 the motor dismantled.

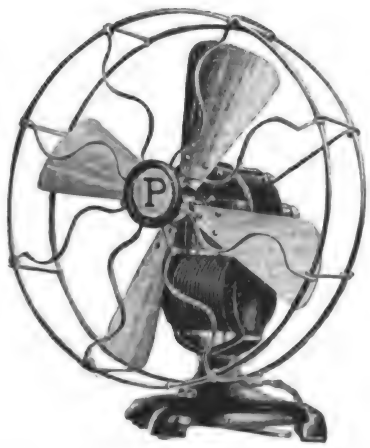


FIG. 27.—PERFECTION BATTERY FAN MOTOR.

The field magnet is cast in one piece and provided with form-wound and hand-insu-

FIG. 28.—PERFECTION BATTERY FAN MOTOR.

lated coils. The armature is of laminated construction with six polar projections and coils. The commutator is of the usual drum form, insulated with hard fibre. The brushes are carbon pencils fed to the commutator in boxes mounted in lugs which are cast on one of the end caps, as shown in Fig. 29.

FIG. 29.—KENDRICK & DAVIS' BATTERY FAN MOTOR.

The mounting of the machine is obvious from the engravings. It has a 6-inch fan, and runs at 2400 r.p.m. when supplied with current at 7 volts. The current taken at this e.m.f. is ½ ampere.

American Blower Company, Detroit, Mich., has improved its method of mounting this season. Fig. 31 shows the new

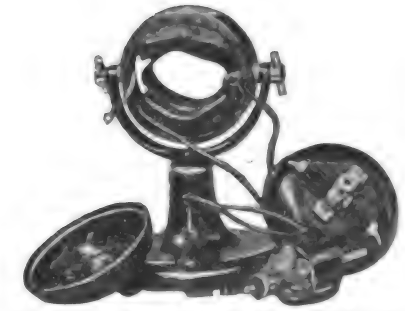


FIG. 30.—KENDRICK & DAVIS' MOTOR DISASSEMBLED.

arrangement, in which the motor is set on a substantial cast-iron foundation, and the

FIG. 31.—AMERICAN BLOWER OUTFIT.

fan casing is attached to the motor frame. Last year the fan casing was mounted on a base and the motor hung from it by braces. The motor used this season is the well-known Westinghouse Type S machine, for standard direct-current voltages. Any standard motor, however, may be used.

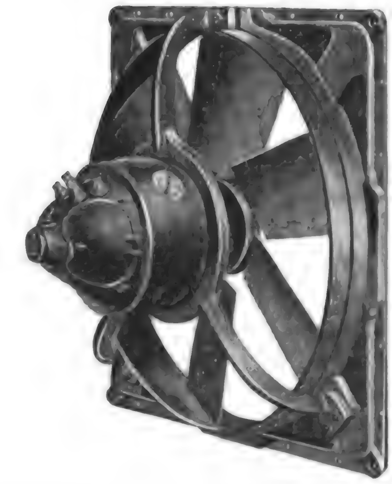


FIG. 32.—TRIUMPH FLAT-BLADE EXHAUST FAN AND MOTOR.

Fig. 32 illustrates the Triumph ventilating outfit built by the Specialty Manufacturing Company, Indianapolis, Ind. The motor is

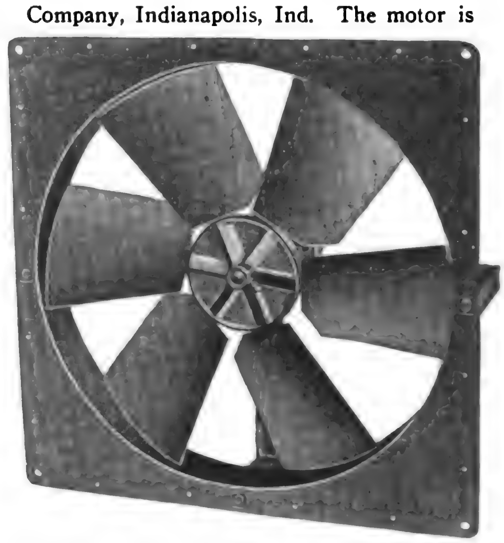


FIG. 33.—EXHAUST SIDE OF TRIUMPH FAN.

bolted to a three-armed spider, which is in turn bolted to a substantial cast-iron wall plate. The fan is mounted directly on the shaft by the motor. No outboard bearing

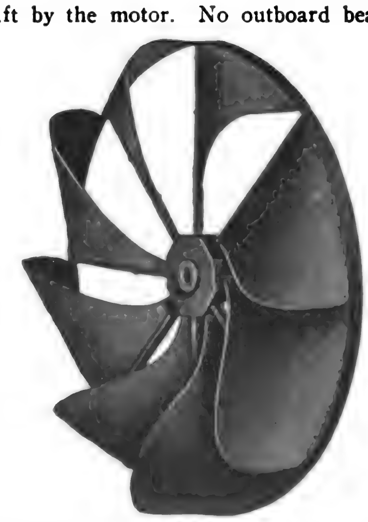


FIG. 34.—TRIUMPH PROPELLER BLADE FAN.

is needed. The method of mounting the fan blades on the hub is shown in Fig. 33, which is a view of the exhaust side of the fan. This type is built for the standard direct-current voltages in sizes of 24, 30 and

36-inch fans, the maximum speeds of which are 900, 700 and 650 r.p.m., respectively. The company also builds the propeller type of fan shown in Fig. 34, with the same style of mounting. The sizes and speeds of this type are 24 inches, 800 r.p.m.; 30 inches, 650 r.p.m. and 36 inches, 600 r.p.m. Speed regulators giving eight speeds, ranging from one-half to full speed, are furnished with both types The outfit comprising a Tri-

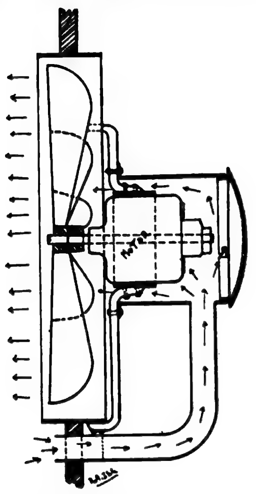


FIG. 35.—VERTICAL SECTION OF ELECTRIC VENTILATING COMPANY'S HOOD.

umph fan and a detachable motor, described two years ago in our annual fan-motor article, is continued as heretofore.

Electric Ventilating Company, Chicago, has brought out an attachment for motor-driven ventilating fans, which is designed to protect the motor from deleterious fumes, gases, etc., and also to provide artificial ventilation of the machine by means of a current of cool air taken from the outside atmosphere. The device consists of a hood completely surrounding the motor and covering one end of it, and a pipe leading from the side of this hood to the outer air, as shown in Fig. 36. The end of the hood toward the fan is open and the fan draws cool air through the pipe and hood, thereby reducing the temperature of the motor by convection. The main body of contaminated air drawn out of the room by the fan does not come into contact with the motor, the hood being interposed. Fig. 35 is a vertical section showing the motor within the hood. When the air or vapors discharged by the

FIG. 36.—ELECTRIC VENTILATING COMPANY'S OUTFIT.

fan are lighter than the outside air, as is usually true, the pipe leading from outside to the hood is located as shown in Fig. 36, so that it will not draw back any of the main discharge. When the main discharge is heavier than pure air, however, the hood pipe is arranged at the top, or exactly opposite to the arrangement shown in Fig. 36.

The following manufacturers are continuing their respective lines, which were fully described last year, no need for changes having developed. The Robbins & Myers Company, however, has added to its line of Standard machines a new Universal fan-motor which will be described next month, the engravings illustrating the constructional details being delayed by the engravers until too late to publish the description in the present article.

The D. L. Bates & Brother Company, Dayton, Ohio.—Direct-current desk, bracket, ceiling and column fans for the standard voltages.

Century Electric Company, St. Louis, Mo. —Alternating-current ceiling fan-motors for the usual frequencies and voltages.

The Colonial Fan & Motor Company, Ravenna, Ohio.—Direct-current desk and ceiling fan-motors for standard voltages.

General Incandescent Arc Light Company, New York.—Paragon desk and bracket fan-motors for standard direct-current voltages.

The Jandus Electric Company, Cleveland, Ohio.—Desk and bracket fan machines for direct and alternating current; also the "Gyrofan" mounting for either ceiling suspension or floor column.

The Pennsylvania Electric Company, Marietta, Pa.—Crescent desk, bracket and ceiling fans for direct-current circuits.

The Robbins & Myers Company, Springfield, Ohio.—Standard desk, bracket and ceiling fan-motors for the standard direct-current voltages.

Sprague Electric Company, New York.—Lundell desk and bracket machines for the regular direct-current voltages and alternating-current voltages and frequencies; also the ceiling fan described in 1903.

Sterling Electric Motor Company, Dayton, Ohio.—Ceiling fans for the usual direct-current voltages.

Western Electric Company, New York and Chicago.—Desk, bracket and ceiling fans for the regular direct-current voltages, as described in full detail last year.

Edison Manufacturing Company, Orange, N. J.—Battery fan motors and batteries.

Knapp Electric & Novelty Company, New York.—Battery fan motors and batteries.

B. F. Sturevant Company, Hyde Park, Mass.—Motor-driven ventilating fans and blowers of both "paddle-wheel" and propeller types, with direct-current motors of different types, according to the class of service, and wound for the usual voltages.

Massachusetts Fan Company, Waltham, Mass.—Ventilating fans adapted for motor drive and designed for the usual classes of service.

The Barney Ventilating Fan Works, Boston, Mass.—Barney "Compound" ventilating wheel, adapted for direct motor drive.

GERMAN CENTRAL STATION STATISTICS.

The *Elektrotechnische Zeitschrift* devotes considerable space to the yearly statistics of German central stations comprising a vast amount of information current up to April, 1904. While the present number of central stations in Germany is over 1100, the statistics cover only 1028 plants, and only those are included which sell current to consumers or supply public lighting. Isolated plants are not included. There were 51 plants having a capacity of more than 2000 kilowatts in 1904. The three largest are in Berlin, and their respective output is 85,136, 30,000 and 25,895 kilowatts. The total capacity of the 51 stations of more than 2000 kilowatts is 296,693 kilowatts, these stations being in 33 cities. The development of central stations and their connections in Germany in general is shown in the following table:

	1894.	1900.	1904.
No. of stations ...	148	652	1,028
No. 50 watt incan. lamps connected.	493,801	2,623,893	5,687,382
No. of 10 amp. arc lamps connected.	12,357	50,070	110,856
H.P. of motors (not incl. trac.)	5,635	106,368	263,036

In recent years several plants have been erected which supply current to a number of cities and towns in a district; thus the Bruehl central station supplies current for lighting and power to 66 towns at a distance of from 9 to 12 miles from the station. On the other hand, there are some small plants which supply current for power purposes to houses for the support of house industries. A typical example is the Anrath plant near Crefeld. All the motors connected to the mains are in this case between ¼ and ½ horse-power, and are used in the silk industry. In recent years the use of power has enormously increased, as is shown in the following table of comparison between the kilowatts used for lighting and for power, traction motors not being included in the latter case:

	Kw. for lighting.	Kw. for power.	No. of motors.
1885	250	.....	.....
1890	3,899	112	28
1895	10,752	2,252	663
1900	21,122	22,037	5,764
1904	36,195	44,448	12,933

There is only one plant in Germany which buys energy in bulk from a larger works and sells it in retail to consumers; this is the Spandau station, which gets the current from one of the Berlin works. Statistical data concerning the systems used are given in a following table:

	No. of works.	Kw. of machines.	Kw. of batteries.	Total capacity in kw.
Direct current with storage batteries..	803	175,263	69,957	245,220
Direct current without storage batteries	40	2,346	.....	2,346
Alternating cur., single ph. and two ph.	41	37,317	400	37,717
Three phase current	63	69,054	1,532	70,586
Monocyclic system	2	1,030	152	1,182
Mixed three phase and direct current .	64	141,330	23,169	164,499
Mixed alternating and direct current ..	15	8,542	855	9,397

Concerning the power used the statistics show that 570 plants with 341,248 kilowatts use steam power, 109 plants with 14,547 kilowatts use water power, 208 plants with 60,672 kilowatts use both steam and water power, and 94 plants of 10,050 kilowatts use gas power.

SOUTHERN MACHINERY DEALERS' CONVENTION.

The executive committee of the Southern Supply & Machinery Dealers' Association held a meeting at New Orleans on February 16 and 17 and made arrangements for the annual convention of the association, which is to take place April 25 to 28, at the De Soto Hotel, Savannah, Ga. The executive committee has appointed Mr. Denny, of the Georgia Supply Company, Savannah, Ga., chairman of the entertainment committee, and Mr. Dissosway, of the Cotton States Belting & Supply Company, Atlanta, Ga., chairman of the transportation committee. Favorable rates have been made with the De Soto Hotel and the programme that has been adopted is expected to be extremely interesting to every manufacturer and dealer in the United States.

The executive committee extends an invitation to all supply dealers, and also to the representatives of the different manufacturers with whom the supply dealers do business, to attend the convention.

The entertainment committee has made arrangements that insure every one present a fine time. Savannah is one of the most attractive cities of the South, and at the time of the year chosen for the meeting, the city will be seen at its best.

Some Recent Electrical Patents

Combined Circuit-Breaker and Motor-Starting Rheostat.—The now familiar automatic-return motor-starting rheostat was developed, of course, in order to guard against the possibility of connecting a standing motor to a supply circuit with the starting resistance partly or entirely cut out. In order to provide the same precaution in another way, the combination starting box and circuit-breaker, illustrated diagrammatically by Fig. 1, has been devised and patented by Robert H. Read, of Schenectady, N. Y. The circuit-breaker consists of a pivoted arm, 4, carrying an insulated contact, 3, which bridges the stationary contacts, 2, when the circuit-breaker is closed, as shown in the diagram. The circuit-breaker arm is held in the closed position by means of the latch, 6, which is pivoted near the potential magnet, 7, and held in the locking position by that magnet. The handle, 9, of the circuit-breaker is not rigidly connected to the circuit-breaker arm, 4; it is mounted on the same pivot, 5, and provided with a dental clutch, 10, as shown in the horizontal view at the bottom of the diagram. A forked arm, 11, under the influence of a spring not shown, normally holds the handle, 9, unclutched from the hub of the circuit-breaker arm, 4. This forked arm is pivoted at 20, and an integral lug at right angles to it is engaged by a bifurcated arm, 12, mounted on the same hub with the finger, 19. The arm, 14, of the starting rheostat is provided with a lug, 18, which engages with the finger, 19, when the resistance is all cut into the circuit.

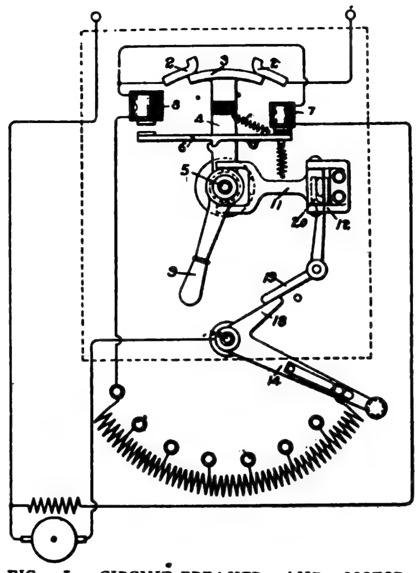


FIG. 1.—CIRCUIT-BREAKER AND MOTOR-STARTER.

Though the description is somewhat complex, the operation is very simple. When the arm, 14, is moved around to the left to cut out the resistance and start the motor, the finger, 19, is released and the spring controlling the arm, 11, throws out the clutch on the hub of the lever, 9, so that that lever cannot actuate the arm, 4, of the circuit-breaker. If the current supply should fail, the potential magnet, 7, will release the latch, 6, allowing the circuit-breaker to be opened by its spring; similarly, if the current taken by the motor should be excessive, the current magnet, 8, will lift the latch, 6, against the restraining influence of the magnet, 7, and thus release the circuit-breaker. As the arm, 11, holds the clutch on the hub of the lever, 9, disengaged, the circuit-breaker cannot be restored by means of the lever, 9. If, however, the lever, 14, is swung back to the zero position, as shown in the diagram, its engagement with the finger, 19, sets the dental clutch, 10, on the hub of the lever, 11, and enables that lever to reset the circuit-breaker. Patent 779,182.

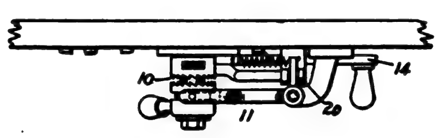


FIG. 2.

Commutator Brush Holder.—One of the disadvantages of the familiar box-type brush holder is that unless a spring is used which takes up a great deal of space, the pressure of the brush against the commutator becomes rapidly lessened as the brush wears away. In order to overcome this, Mr. Ernst Woehr, of Wilkinsburg, Pa., has devised the arrangement shown in Fig. 3. The brush is pressed toward the commutator by the toggle links 6 and 8, pivoted to the framework at 5 and having the knuckle at 7. A spiral spring, 9, pulls on the link, 6,

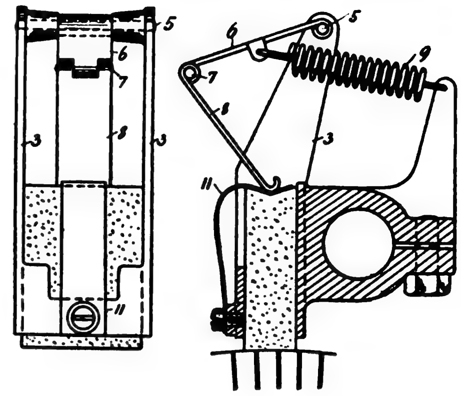


FIG. 3.—COMMUTATOR BRUSH-HOLDER.

and forces the brush downward; as it wears away and the lower end of the link, 8, follows it down, the toggle angle becomes

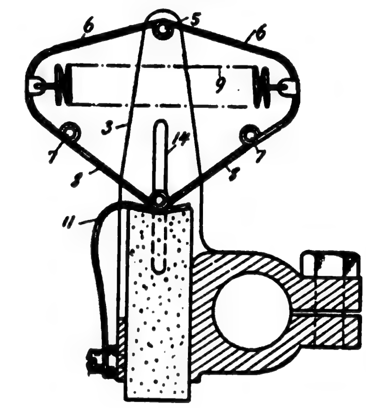


FIG. 4.—COMMUTATOR BRUSH-HOLDER.

greater and greater, increasing the leverage of the spring, 9, over the toggle sufficiently to compensate for the decreased pull of the spring as the spirals contract. A thin con-

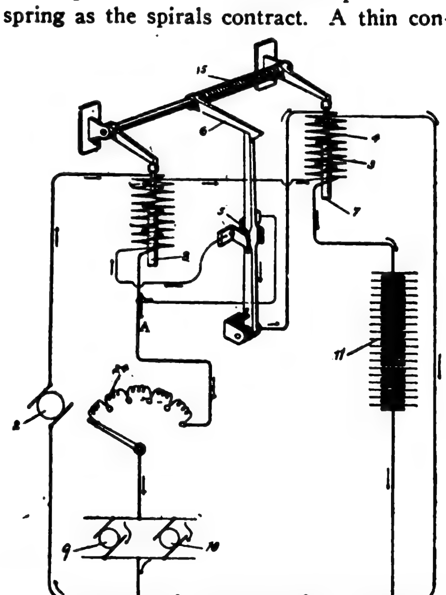


FIG. 5.—SCOTT'S DOUBLE-DUTY CIRCUIT-BREAKER.

ducting leaf, 11, is secured at one end to the brush box, and its other end is pressed against the upper end of the brush by the toggle link, 8. Fig. 4 shows a modification in which two toggles are used, the two being drawn together by a spring attached to both.

The lower ends of the links, 8, 8, are pivotally connected and the pivot pin extended through a guide slot, 14, to keep the ends on the middle of the brush-end; the latter is shaped to facilitate this in both cases. Patent No. 777,709.

Double Duty Circuit Breaker.—Ordinary overload circuit-breakers for the protection of electrical apparatus are, of course, perfectly familiar, and reverse-current circuit-breakers for preventing current flow in the wrong direction are also well known; Fig. 5 illustrates diagrammatically an ingenious combination of these two classes of apparatus which has been patented by Mr. William M. Scott, of Philadelphia. The circuit-breaker contacts are represented conventionally by the lever and jaws, 5. The lever is held in by the latch, 6, under the influence of the spiral spring, 15, and may be released by either of the solenoid plungers, 7 and 8. The two solenoids are provided with differential windings, the potential windings of the two being connected in series through the circuit-breaker and across the supply circuit, *A-B*, to which a storage battery, 11, is also connected. The series winding of one solenoid is in series with the motor circuit, *A-B*, and the series winding of the other solenoid is in series with the storage battery. The potential winding of the solenoid, 7, and the adjustment of its plunger are such that under normal conditions the potential winding is almost strong enough to lift the plunger. Consequently, the amount of normal current through the series winding must be very great in order to overcome the potential winding and trip the circuit-breaker. The motors, 9 and 10, and the storage battery, 11, are supposed to be mounted together with the circuit-breaker on a railway car, such as a mining locomotive, and the chief function of the circuit-breaker is to guard against excessive current delivery to or from the storage battery. For example, if the generator, 12, should fail for any reason, the battery, 11, would discharge back into the line, if the line circuit were closed, and it would discharge through the motors in any event. So long as the current taken by the motors remained normal, the cumulative effect of the potential winding and the series winding of the solenoid, 7, would be insufficient to raise the plunger, but if excessive current should flow from the battery to the motors, the plunger, 7, would be lifted and the circuit opened. Again, if upon the failure of the generator, 12, the line circuit remained closed, the storage battery would send a reverse current through the series winding of the solenoid, 8, and the cumulative effect of the series and potential windings would lift the plunger and open the circuit-breaker. Patent 779,376.

CENTRAL STATION ENGINEERS.

V.

Louis A. Ferguson.

Louis A. Ferguson was born in Dorchester, Mass., August 19, 1867. He was educated in the Boston public schools, graduating from the Dorchester high school in 1884. He then entered the Massachusetts Institute of Technology, and was graduated from that institution in 1888 with the degree of Bachelor of Science in Electrical Engineering. His thesis work consisted of original experiments to determine the "Law of Relation between Candle-power and Current, Voltage and Energy Consumed in Incandescent Lamps." At about the time that Mr. Ferguson was completing his studies at the Massachusetts Institute of Technology, the Chicago Edison Company began to develop its policy of expansion and the officials of the company were looking for competent engineering talent to carry out their plans. Mr. Ferguson, whose college work had attracted considerable attention, was offered a position in the company's underground department shortly after his graduation, which he accepted. His advancement thereafter was steady and rapid. In 1889 he was assistant electrical engineer of the construction department, and in 1890 he was appointed to the position of electrical engineer. His experience up to this point had been wholly on the engineering and operating side of the business, but the marked ability with which he handled such commercial work as came within his province attracted the attention of the management, and in 1893 his duties were enlarged to include the entire supervision of the company's contract business in addition to his engineering work. Mr. Ferguson was remarkably successful in this new field, particularly in the negotiation of valuable long-term contracts with some of Chicago's largest mercantile establishments, and on June 1, 1897, President Insull appointed him general superintendent of the company, in charge of the operating and electrical engineering departments, as well as the central station and isolated plant business. A year later Mr. Ferguson was also appointed general superintendent of the Commonwealth Electric Company.

LOUIS A. FERGUSON.

Mr. Ferguson's wide experience during his connection with the Chicago Edison Company has made him a recognized authority in this country on central station practice, and during the last fifteen years he has contributed a considerable number of papers to various associations, scientific societies and colleges. In 1895 he was on the staff of lecturers at the University of Wisconsin, and delivered a lecture on "Electrical Engineering in Modern Central Stations," which was subsequently published by the university. In 1896 Mr. Ferguson read a paper at the convention of the National Electric Light Association, held in New York City, May 5, 1896, on "The Commercial Value of Acetylene Gas as an Illuminant," giving the results of his experiments made with Messrs. Wilson and Knapp at Spray, North Carolina, in 1895, in the production of calcium carbide and acetylene gas. This paper was published by order of the National Association, and is considered one of the ablest contributions that have been published on this subject, being widely reviewed at the time by the technical press. Another important contribution was his work in conjunction with Dr. Louis Bell and James I. Ayer upon the preparation of a suitable specification for a standard incandescent lamp and the determination of a proper method for the commercial application of this standard. The result of this work was presented in an elaborate report entitled "Standard Candle-power of Incandescent Lamps," which was submitted to the National Electric Light Association at Niagara Falls, January 10, 1897. The subjects of other papers read before technical societies or published in the technical press are as follows: "The Economy in Distribution of Electric Energy," "Development of a Central Lighting System," "General Distribution from Central Stations by Direct Current," "The Methods of Charging for Electrical Energy," "Central Station Advancement," "Progress of Central Stations," "Storage Batteries for Small Stations," "Distribution of Electrical Energy in Large Cities," "Central Station Operation," and "Rates."

On July 9, 1902, the directors of the Chicago Edison Company and the Common-

wealth Electric Company recognized the importance of Mr. Ferguson's services by electing him second vice-president of both companies, which position he holds at the present time.

Mr. Ferguson was elected president of the Association of Edison Illuminating Companies for the year 1901-2, and re-elected to the same position for the year 1902-3. He was also elected president of the National Electric Light Association for the year 1902-3, and is now a member of the executive committees of both associations. He is also a member of the board of managers of the American Institute of Electrical Engineers, and at the International Congress, held in St. Louis last summer, he contributed a paper entitled "Underground Electrical Construction."

Mr. Ferguson is married, and resides in Evanston, one of the most beautiful suburbs of Chicago. While not a club man in the ordinary acceptation of the term, he belongs to a large number of clubs, including the Union League, Merchants, Chicago Athletic, Evanston Country Club and the Onwentsia, Glenview and Edgewater golf clubs.

Mr. Ferguson is credited with being the first engineer in this country to suggest a central station system generating three-phase alternating current with transmission lines to sub-stations, operating rotaries, converting from alternating to direct current for general distribution.

NOTES.

Results of a Year.—The International Committee of Young Men's Christian Associations has just issued a handsome booklet showing the progress of the Y. M. C. A. Railroad Department for the past year. The development of this branch in many respects has been phenomenal.

Directness of Exhaust-Steam Connections especially where high vacua are desired, is generally provided for in power-station design, but the relative effect of interposed valves is often greater than supposed. In a recent test at the Battersea electric central station, London, it was found that of a drop of vacuum from engine exhaust to condenser of 1½ in. of mercury, 0.8 in. was due to a non-return valve.

Evening Lectures at the Brooklyn Polytechnic Institute.—The first of a series of eight two-hour lectures on electrical power transmission was delivered by Dr. F. A. C. Perrine on February 9 at the Brooklyn Institute. This lecture had for its subject "The Economics of Transmission Problems.". The topics discussed by the speaker were: Adequacy of Supply, Extent of Market, Character of Market, Competitive Fuels, Transportation, Distribution, and the Importance of Controlling Property. On February 14 Mr. W. S. Barstow delivered his sixth lecture on "Central Station Practice," in which he discussed distributing systems. Mr. Barstow went very thoroughly into the details of the construction of distributing systems, such as ducts, cables, manholes, etc.

Size and Lift of Stop Valves.— It is the almost universal practice to make the diameter of the stop valve on a boiler the same as the diameter of the supply steam pipe to prevent throttling and to make the maximum lift equal to one-fourth of the diameter, in order that the cylindrical area of escape may be equal to the cross-section or bore of the pipe. Experience shows, however, these are extreme views of a valve's requirements as a local contraction in a pipe causes very little interference with the flow of steam, and in practice it is seldom a valve is open more than one-third to one-half the extent which by calculation would appear to be necessary.—*Exchange.*

Central Station Statistics.—In a very able paper on "Central Station Design," read recently by Mr. I. E. Moultrop before the American Institute of Electrical Engineers, the author stated that there are now 3738 electric power stations, the total cost of which was, in round numbers, $500,000,000. The income from these stations from lighting and power service aggregates $90,000,000 per annum. The aggregate power developed by prime-movers in central station work is 1,300,000 horse-power, of which 438,000 horse-power is hydraulic. There are in use 419,000 arc lamps and 19,000,000 incandescent lamps. In the discussion of the paper, President Lieb gave the interesting information that extensive observations taken in one of the principal large New York central station plants had shown that of the total generating capacity 10 per cent was used only twenty-five hours per annum, and that twenty-five hours was contained in a single month; 25 per cent of the plant was used seventy-five hours per year, all within the scope of two months, and 50 per cent was used only 500 hours per year, within the limits of seven months.

Steam Pipe Covering Tests.— Tests of a steam pipe covering of asbestos 1.53 in. thick and made in flat sections 3 by 2 ft. in size, wrapped around the pipe and laced with copper wire, were reported recently in *The Electrician*, of London, from results obtained at the National Physical Laboratory. The covering averaged 2 lb. weight per running foot or 1.7 lb. per square foot of the external surface of the 4-in. pipe used in the tests. The trials were conducted in a usual manner with a 14.34 ft. length of the pipe inclined 6 in. in this distance. The radiating surface of the pipe was 16.85 sq. ft. With a steam temperature of 392.7 degs. and air temperature of 67.7 degs., the condensation of the bare pipe was 1.66 lb. steam per square foot per hour, and the heat loss 4.27 b.t.u. per square foot per hour per degree difference in temperature. With a steam temperature of 393.4 degs. and air temperature of 64 degs., the condensation with the covered pipe was 0.212 lb. per square foot per hour, or 0.54 b.t.u. per square foot per hour per degree. It was calculated that the losses with steam pressures of 190, 200, 210 and 220 lb. by gauge were, for the covered pipe, 168.4, 170.6, 172.7 and 174.6 b.t.u., respectively, per hour per square foot, and, for the bare pipe, 1339, 1357, 1373 and 1389 b.t.u., respectively.

Pacific Coast Water Powers for Railroad Work.—Mr. Robert McF. Doble, of San Francisco, recently read a most interesting paper before the Pacific Coast Railway Club of that city, on "The Use of Pacific Coast Water Powers in the Electrical Operation of Railroads," in which he pointed out that although only a small portion of the available water powers on the Pacific Coast has been developed, the present conditions would appear to make the operation by electricity of some of the railroads in that section profitable. The author pointed out that the capacity of the steam locomotive must necessarily be that required to exert its maximum effort, even though the duration of maximum pull be extremely short, whereas the average load of a power station supplying a railroad line will be much less than the total maximum capacity of the electric locomotives supplied by it. This would materially reduce the cost of operating, especially under the conditions found on the Pacific Coast, where several power plants can feed into a single network. Reference was also made to the reduction in cost and maintenance of the roadbed of the electrically-equipped railroad as compared with one using steam locomotives, the possible increase in the capacity of existing railroads, and the ease of operation and maintenance.

The Search for Men.—In an interesting address on this subject recently delivered by Mr. H. J. Hapgood at a local branch of the Young Men's Christian Association, the speaker stated that one of the greatest evils among business customs is the indiscriminate giving of letters of recommendation by employers. He said that the best testimonial he ever saw contained exactly fifteen words, reading as follows: "Worked for us four years at $50 a week; wish we could have him back." He also pointed out the injustice of the assumption by employers that a man over forty years old is ineligible for responsible positions, and predicted that within a few years large employers would abandon the present prejudice in favor of men between thirty and thirty-five years of age, which is now working serious injustice to older men. He stated that a study of the employment problem had led him to believe that the demand for capable men in almost every line of skilled employment, except artisans, is far in excess of the supply. "High-salaried positions," he said, "are not vacant, but they are filled by men not big enough for them. Over 1000 men of the proper ability could secure positions in New York to-morrow at salaries of $5000 a year and over." It should be carefully noted that Mr. Hapgood, in all of his statements, prescribed men of the *requisite degree of ability*, not men who fancy themselves capable of filling any position.

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CONTENTS.

Motor-Driven Steam Plant Auxiliaries.

The proposition to drive all the steam plant auxiliaries of an electric lighting or power station by electric motors is a most attractive one on the surface, and we have always advocated this practice—under proper conditions. No rule is universally applicable without discrimination, excepting, of course, the few fundamental rules in the moral code. Motor-driven pumps, fans, etc., are immeasurably preferable to the steam-driven machines in all cases where there is available from other sources a sufficient supply of feed-water-heating steam which would otherwise be wasted. For the vast majority of cases it will be found safe to adopt the policy of using enough steam-driven apparatus to furnish all the exhaust steam needed under the most exacting conditions for heating the feed-water, and, if there remains any auxiliaries not provided for, to apply motor drive to those. Naturally, in following this policy, those auxiliaries which are worst adapted for motor drive should be put in the steam class first, arranging the list as far as possible, so that the last machines to be considered will be those best fitted for motor driving.

This is not all there is to the problem, however. It is not enough merely to put down the list of machinery and blindly follow the general policy outlined above. In many cases it may be found upon careful analysis that it would pay deliberately to use a non-condensing main engine in order that the auxiliaries may be motor-driven, the feed-water heat being obtained, of course, from the main engine exhaust. Where water is free and the character of the load not ordinarily favorable for condensing engines, it will nearly always be preferable to use a non-condensing compound engine and drive all of the auxiliaries by electric motors, excepting the exciter dynamos in a small station generating alternating current. These may always be profitably belted to the alternators or to the engines driving them. Even in a few cases where boiler feed-water had to be bought, it has been found economical to run non-condensing main engines in order to get the exhaust heat for the feed-water. Unless the engine exhaust is insufficient in such cases, motor-driven steam-plant auxiliaries throughout will always be found preferable if they are properly designed and installed.

The alleged inflexibility of control sometimes urged against motor drive for pumps and blowers exists only in the imagination of steam-drive partisans or in the practice of hopelessly incompetent builders. That there is the slightest difficulty in regulating the work of a motor-driven machine of the type named will not be conceded for a moment by any progressive engineer. Direct-current motors, of course, should invariably be used where speed regulation is needed—and it is indispensable in about 99.9 per cent of the cases. There is not a station in existence where direct current is not necessary, and it is a simple matter to provide a supply large enough to include pump and blower motors. Given such a supply, the engineer who could not provide an efficient, simple and easily-maintained variable-speed motor would deserve only the usual fruits of dire failure—not sympathy or extenuation. But it should never be forgotten that motor drive is not inherently an engineering panacea.

High-Tension Insulator Pins

The question of wooden *vs.* iron insulator pins for high-tension lines drew out considerable discussion at the Power Transmission section of the recent International Electrical Congress, even though the subject was not specifically mentioned on the program. The insulator and pin are so intimately related that any discussion of insulators must sooner or later bring up the question of pins. The evidence is not all in as yet on either side of this question. The leaning of most of the congress members seemed to be toward the use of wooden pins for ordinary transmission work, although it was admitted that steel towers and long conductor spans might be the practice of the future on the more important lines, and that with these would come the use of steel pins, with insulators electrically strong enough to permit of bringing ground potential clear up into the insulator, as is done when metal pins are used.

The arguments on wooden *vs.* iron pins take a peculiar turn sometimes. One man will argue that if the insulators are made good enough, they do not need any assistance from the pins as far as insulation is concerned. Another will follow up that argument by saying that if the insulators were so good that iron pins could be used, they would be good enough so that there would be no trouble from leakage and burning of wooden pins if wood were used; therefore, "why use iron"? There is apparently a good deal of truth in this argument, but as we said before, the evidence is not all in. There are apparently some contradictory things about the evidence thus

far presented. On the face of it, the fact that sufficient leakage can be obtained over a given insulator under given conditions to burn or disintegrate a wooden pin would seem to show that the use of iron pins would only transfer the trouble to another point, either where the pin enters the cross-arm or where the cross-arm is attached to the pole. On the other hand, one participant in the Congress discussion cited his experience to the effect that the substitution of iron for wooden pins under the same insulators in a certain district had resulted in an enormous reduction in the number of insulator break-downs, in locations where wooden pins would be destroyed in four to six months.

Just why iron pins should give satisfactory service under insulators which permitted enough leakage to rot out or burn wooden pins is difficult to explain on sound theoretical grounds. The experience of one pioneer company in very high voltages has shown that there may be enough leakage over cross-arms and poles so that the concentration of this leakage by the use of metal lag screws and braces may produce serious results in the way of burning at these points. In view of this, it is possible, although not absolutely proven, that the use of iron pins in high-tension insulators which will not give satisfactory service on wooden pins would cause a burning or rotting at the points where the pin enters the cross-arm or at the point where the cross-arm is attached to the pole.

As to whether or not there is a certain insulating value in that part of a wooden pin which is entirely protected by the insulator, there is no room for argument. Dry wood properly treated is a good insulator, and if the core of a glass or porcelain insulator is filled with the end of a dry wood pin rather than by a metal pin, the equivalent thickness of the insulator at that point is certainly increased a certain amount. There is apparently some disagreement among high-tension transmission experts as to the cause of the burning and disintegrating of pins. Some apparently think it due to leakage directly through the insulator, and others attribute it to leakage over the surface of the insulator. There is also a discrepancy in the use of the terms describing the nature of the phenomenon which causes pin burning. That the burning of wooden pins starts by the disintegration caused by a brush discharge seems generally accepted, but as to just where this brush discharge takes place in practice on a working insulator on a pole line doctors disagree, and we need more testimony based on experience and careful observation.

Machine-Tool Drive.

An interesting paper on the electric driving of machine-tools was read recently before the Engineers' Club, of Philadelphia, by Mr. E. L. Walker. The author brought out several important points, but made the curiously inconsistent statement that "the ideal condition would be to get constant torque which would necessitate a larger horse-power at the higher speeds; nevertheless, it is a step in the right direction to get even a constant horse-power at all speeds." As he had already pointed out in a preceding paragraph, all of the multi-voltage systems give constant torque at all voltages, and therefore at all speeds, excepting such gradations as are effected by field control; but this is not always satisfactory for the reason that most machine tools require the greatest power at the slowest speeds. Power being the product of torque and speed, it is obvious that the ideal condition for tools requiring maximum power at slow speeds is decidedly not that of constant torque, but that of torque varying inversely with the speed and at least in direct ratio. This result is obtained by means of field regulation alone, and this is characteristic of many motors now manufactured.

The author also appeared to advocate the use of a mechanical speed-changing arrangement comprising an appalling conglomeration of gears, clutches, etc., which he characterized as having "solved this problem very nicely," and stated that "A speed-changing mechanism properly designed to give speeds in the ratios of 1 to 2, 4 to 8, etc., in connection with a variable-speed motor with a range of 1 to 2, will give every speed between the lowest and highest range." He might have omitted the variable speed motor and substituted some of the finely-graded speed-changing devices; then his mechanical museum would have been complete. Less discriminating engineers, however, would probably be satisfied to labor along with a variable-speed motor having a maximum range of 6 to 1, together with the ordinary simple back-gears on the machine tool.

A feature not discussed in the paper is that of controller arrangement. A motor regulated by field variation has the advantage that the controller may be made much smaller than one of any other type. This makes it easier to arrange the controller for direct manipulation by the tool operator; in fact, in many cases, the controller may be mounted directly on the apron of a lathe carriage or some convenient part of another form of tool, which is rarely, if ever, feasible in the case of other types of controller. There is the attendant disadvantage, however that the motor starting-box must be separate from the speed-regulating controller, if an ordinary type of motor starter be used; the consequence would be that with frequent starting and stopping, mounting the speed-controller on the machine tool would not be an appreciable improvement over a combined motor starter and speed regulator with the usual mechanical connections. But there would be a conspicuous advantage in using some one of the several good motor-starters controllable from a distance, together with a field-control rheostat, the latter being mounted within easy reach of the machinist and including in its construction a small switch, actuated by the speed-regulating handle, for cutting in and out the motor starter. The latter would be mounted preferably, but not necessarily, on the frame of the motor.

Why Not Auto Fire Engines?

If the familiar steam fire-engine is not an anachronism in this age of electricity and gas engineering, it comes perilously near it. In view of the remarkable progress in motor-driven vehicle design and construction during the past few years, it seems rather odd that the old-time fire engine, with its profusion of inutile polished surfaces and its inconsistent capacity for belching forth amazing volumes of carbon dioxide has not been ere now threatened with extinction by one or the other of the principal types of automobile, or a combination of the two. It requires no great imaginative power to discern the advantages that could be embodied in an automobile fire engine of the combination type, for example, as compared with the ancient form now persisting. With an internal combustion engine driving a direct-current dynamo at constant speed, and motors supplied from this dynamo and driving the traction wheels and pumps of the outfit, a speediness and facility of control could be obtained which is absolutely out of the question with the old type of machine. Some little work has been done in this or a similar direction, we believe, but no tangible results are manifest. Of course, one serious obstacle in the way of progress in this particular field is the difficulty in producing the necessary "change of heart" in the proper municipal officials.

DESIGN AND CONSTRUCTION OF SMALL DYNAMOS AND MOTORS.

BY CECIL P. POOLE.

Commutator and Brush Holders.

By far the wisest course for the amateur dynamo or motor builder to pursue with regard to the construction of commutators and brush-holders is to buy these from some of the many manufacturers of such apparatus. In buying a commutator it is necessary to give the manufacturer (1) the diameter of the barrel, (2) the width of barrel face parallel to the shaft, (3) the diameter over the lugs, (4) the diameter of the shaft-hole, (5) the voltage of the machine, and (6) the current per commutator segment. Although each

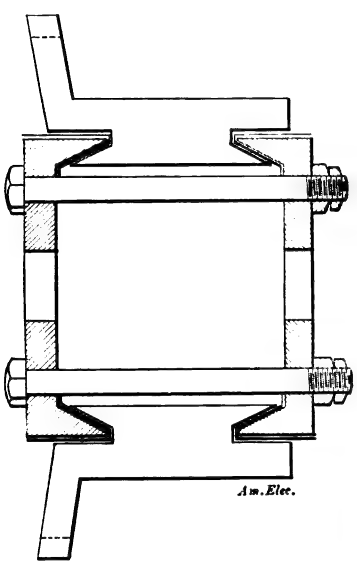


FIG. 24.

brush will doubtless touch two or more segments at any instant, it is well to put the current per segment at twice the current per armature wire when ordering a commutator.

For brush holders, the builder cannot do better than buy a set of the familiar Bayiis reaction holders and arrange his brush-holder mounting to suit them.

However, if the ambitious amateur is determined to make his own commutator and brush-holders the types herein described will be found easier to construct than the more conventional forms with which commercial machines are commonly equipped. Commutators of larger sizes may be constructed readily and cheaply along the lines indicated in Figs. 24, 25 and 26; that is to say, commutators which are large enough in diameter to give room for the

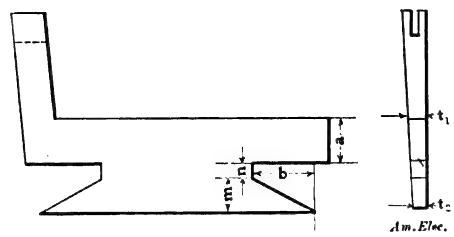


FIG. 26.

clamping bolts between the under edges of the segments and the shaft. The segments are held together by two cast-iron plates or discs and four finished machine bolts as indicated in Fig. 24, which shows two diametrically-opposite segments, two of the four bolts, and cross-sections of the clamping plates. The mica insulation between the flanges of the plates and the recesses in the ends of the commutator bars is indicated by the thin black lines between the opposing faces of these parts. This insulation should in all cases be not less than 1-16 inch thick. The essential dimensions on the end-plates and each segment are given in Table XV, reference letters being used to identify the various diameters and lengths. The distance, lengthwise of the bar, between the recesses in each commutator bar should be approximately one-half as great as the width of the commutator face parallel to the shaft.

TABLE XV.
Commutator Data.

Barrel diam., D_k =	Up to 3"	3" to 6"	Over 6"
Dimension a =	1/4"	3/8"	5/8"
Dimension b =	3/8"	1/2"	5/8"
Dimension c =	3/16"	5/16"	3/8"
Dimension m =	3/16"	1/4"	5/16"
Dimension n =	5/32"	5/32"	5/32"
Diameter D_{ka} =	D_k — 13/16"	D_k — 1 1/16"	D_k — 1 9/16"
Diameter D_{kb} =	D_{ka} — 1/8"	D_{ka} — 1/8"	D_{ka} — 3/16"
Diameter D_{kc} =	D_{kb} — 3/8"	D_{kb} — 1/2"	D_{kb} — 5/8"
Diameter D_{kd} =	D_{kc} — 1/4"	D_{kc} — 5/16"	D_{kb} — 3/8"
Diameter D_{kh} =	17/64"	25/64"	33/64"
Diameter D_{ko} =	D_s — 7/64"	D_s — 7/64"	D_s — 7/64"
Thickness t_1 = in all cases ($\pi \times D_k \div$ No. of bars) — 0.03"			
Thickness t_2 = in all cases ($\pi \times D_{kc} \div$ No. of bars) — 0.03"			

The mica strips between adjacent bars *must* be 30 mils thick and absolutely uniform.

The building up of the commutator is a trying job. The bars must be assembled loosely, with the mica strips between them, and gradually drawn together radially until the mass is perfectly tight. This is easiest done by first setting the bars on end on a level surface, in a hole in a block of wood about one-half as thick as the commutator face is wide, so that half of each segment stands above the surface of the block; and then drawing the segments centerward by means of screws in a ring of iron having a bore about 1½ inches greater than the diameter of the commutator barrel is to be. Curved shoes must be interposed between the screw points and the commutator bars to prevent gouging the latter. This assembling ring with screws and shoes is shown in Fig. 27. It will be noticed that the ring has flanges which extend beyond the heads of the set screws; these are for the purpose of chucking the ring for turning up the commutator, and in tightening up the set screws when assembling the segments care must be taken to keep the rough circle described by the outer faces of the segments concentric with the assembling ring.

When the segments have been drawn toward the center of the mass as tightly as possible, the assembling ring is chucked in a lathe and the inner circle of the segment edges trued up; next, the recess in the end then exposed must be tooled to the proper dimensions. The assembling ring is then reversed in the chuck and the recess in the other end tooled out to size. The end-plates are then put in place, with their intervening insulation, and the clamping bolts tightened up solid; then the whole structure is mounted on a mandrel, the assembling ring removed, and the commutator barrel and lugs turned down to size. It will be obvious, upon consideration of the impossibility of centering the segments in the assembling ring with absolute accuracy, that much more allowance for finish must be made in the segment pattern than would be allowed for ordinary work.

For commutators larger than 2 inches

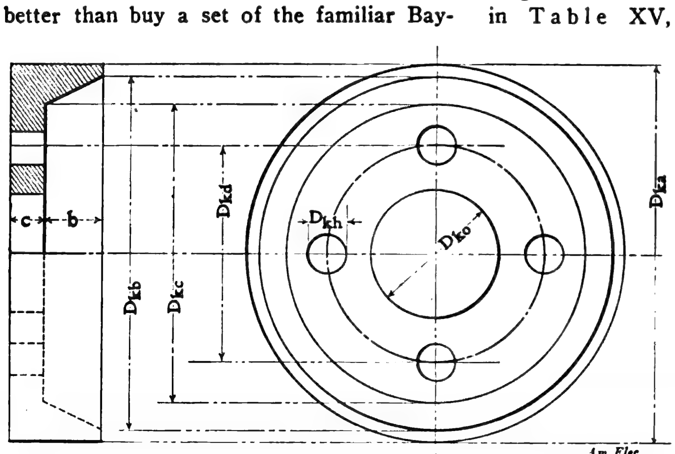


FIG. 25.

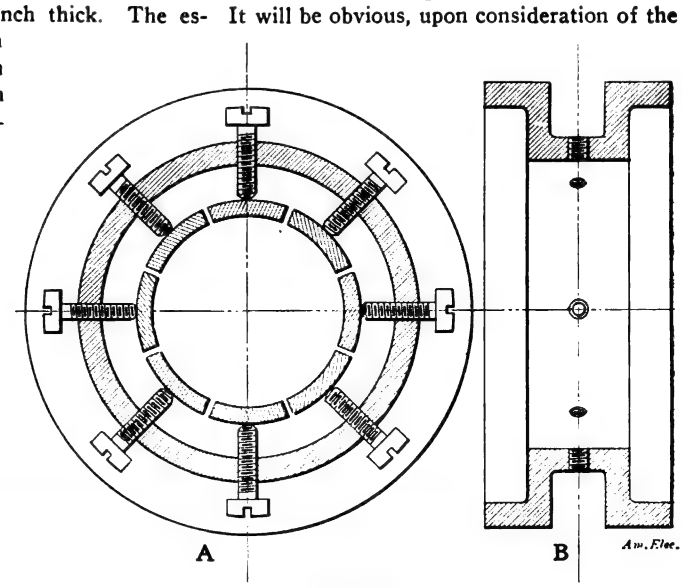


FIG. 27.

barrel diameter but not large enough to permit the construction shown in Fig. 24, the clamping plates should be made with central hubs projecting into the commutator almost far enough to touch each other, and the bolt-holes omitted. After the commutator segments have been tooled out on the inside and both ends, one of the clamping plates should be slipped on the shaft up against the shoulder of the *a* and *c* parts, the mass of segments (still held in the assembling ring) set into the flange of this plate, and the second plate then set in place in the outer end of the commutator and tightened up by means of a nut on the shaft, the outer end of the part, *c*, of the shaft having been threaded for this purpose.

For commutators of 2 inches barrel diameter or smaller, the easiest method is to cast the commutator in a solid piece and saw it into segments on a milling machine or with a milling attachment to a lathe. The solid casting should first be bored out to the diameter D_{kc} and mounted on a mandrel; then the ends should be finished up and a rough cut taken over the barrel face merely to true it with the finished recesses in the ends. Next, a hard wood mandrel should be made to fit the bore of the casting very snugly, the mandrel extending beyond the ends of the casting only far enough to give ample support to the edges of the metal around it. The casting may then be centered in a chuck, using curved shoes between the chuck jaws and

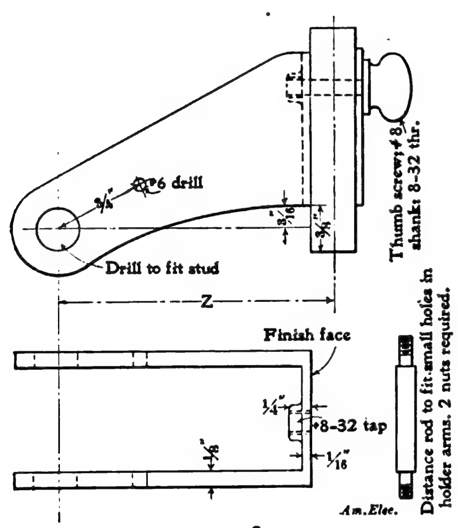


FIG. 28.

the casting which encircle the entire casting; the chuck jaws should catch only enough of the casting to hold it securely. The casting may then be slitted from the free end to a point well beyond the center of its length, using a saw 25 mils thick and cutting as many equidistant slits as there are to be commutator bars. Then the casting is to be reversed in the chuck and the other end slitted in the same way, the shoes under the chuck jaws serving to hold the segments in place during the final slitting of the casting. The slits last cut must, of course, match *absolutely* those first cut in the other end of the casting, so that the sides of the resulting segments will be true. The commutator is then assembled between the end plates without the use of an assembling ring, the nut on the shaft being relied on to draw the segments to place. During the tightening up of the nut, however, the faces of the segments should be tapped gently with a wooden mallet to assist the nut in overcoming the sliding friction between the beveled faces.

The easiest form of brush holder for the

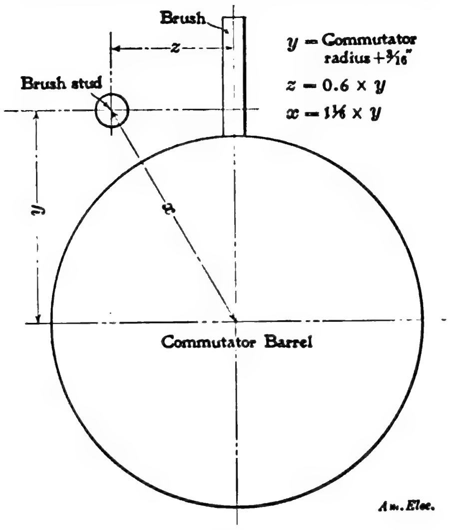


FIG. 30.

amateur to make is the pivoted type, shown in Fig. 28. This is mounted on the brush stud with its tension collar, Fig. 29, between its lugs and the spring in place. The carbon brush is bolted to the face of the holder with a single wing or thumb screw, a thin plate being used to distribute the pressure of the screw head. Fig. 30 shows how the distance from the center of the brush to the center of the pivot hole and the distance from the center of the shaft to the center of the stud are determined. The sketches give all necessary information as to dimensions and finish. The holder is of cast composition, of course.

THE TELEPHONE SUB-STATION AND ITS CONNECTION TO THE CENTRAL OFFICE.

BY A. DALLAM O'BRIEN.

By no means the least important problem that confronts the telephone engineer is the arrangement of the sub-station lines which radiate from the central office and the equipment which is necessary at the sub-station. The sub-station line has its beginning at the main distributing frame, as the connection from this point to the switchboard forms a part of the internal equipment of the exchange itself and simply furnishes a means of extending the outside line to the switchboard. The dividing line between the inside and outside portions of the sub-station line occurs absolutely at the arresters, which are located on the main distributing frame.

In large offices the outgoing sub-station lines are led from the arresters by means of cables to the underground conduits which enter the building. The size and number of pairs of conductors in these cables depend largely upon the length and number of the lines terminating at the office, the cables ranging from those having fifty pairs of conductors of No. 16 or No. 18 wire to those having four hundred pairs of No. 22 wire, these latter finding their principal field in the larger cities. The office manhole plays a most important part in the outside distribution system, as it is from this point that the subway leading to the office begins. The cables coming from the office are brought into this manhole and their conductors spliced to conductors in other cables by which they are led towards the sub-station.

It often happens that the location of a central office is such that the entering lines cannot all be brought in through one office manhole; in such cases several manholes are provided, each having a line of conduit leading from it to the office. There are a number of methods in common use, by means of which the underground lines are arranged for distribution to the sub-stations, and several of these methods will be described in detail.

The terminal pole block system is very largely used in cities and where the right of way over housetops is easily secured, furnishes a ready solution for the distribution problem. The territory to be served is divided into blocks and a terminal pole located preferably in a small street or alley as near the center of the block as possible. The main conduit line is connected by means of a single line of conduit running from a manhole in the main line to the base of the terminal pole. This single line is technically known as a lateral, and the conductors for serving the block are carried in a cable from the manhole in the main line to the base of the terminal pole, where the cable is brought up above the ground inside an iron pipe to a point on the pole some eight or ten feet above the ground level. From this point the lead-covered cable is carried up the side of the pole to within three or four feet of the top.

The top of the pole is equipped with a cable box which has a capacity of from fifty to two hundred pairs, according to the requirements of the block. The cable boxes for this class of work are provided with two sets of lugs or connectors, one set serving to carry the conductors from the cable and the other to carry the line wires leading to the sub-stations, the two sets being electrically connected by a fuse. The cable is ended at the base of the box with a pot-head and weather-proof wires spliced to the cable conductors and fanned out to the lugs or connectors on the cable side of the box. The terminal pole also carries an iron distributing ring on which are mounted glass insulators, the number of such insulators depending upon the diameter of the ring, which varies with the capacity of the cable box.

The sub-station lines are led from the line side of the box to the insulators on the ring, where they are connected to weather-proof wire conductors which lead directly to the sub-station, the insulators serving to take up the strain due to the span and to prevent any strain coming upon the wires in the cable box. It is, of course, advisable that the length of the span from the distributing pole to the sub-station be made as short as possible, although there are cases where spans of from 300 to 400 feet are necessary.

The span from the terminal pole is fastened to the outside of the sub-station in one of a number of ways. It may be terminated on pins mounted on a wooden trestle on the roof, or on a more durable structure of iron pipe, and from this point led down the side of the building wall to insulators fastened on the wall at the point of entrance to the building. Where the span is short the trestle may be dispensed with and the wires connected directly to the insulators on the wall. The entrance to the building is most conveniently effected through the top of a window-frame, holes being drilled through the frame and hard rubber tubing slipped through the holes, the tubing extending an inch or two on the outside. The line wires are brought into the sub-station through the tubing and are then led directly either to the protector or to the instrument: in the former case the wires to the instrument are led from the protector. The use

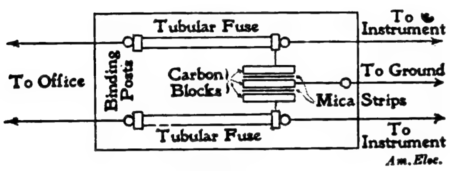


FIG. 1.

of the sub-station protector is not always necessary, but where the outside span crosses or comes in the vicinity of trolley wires or high-tension lines, it is absolutely necessary for the protection of the subscriber that provision be made at the sub-station to open the line in case of an accidental cross with a high-tension wire. The type of protector that is usually employed for this purpose is shown in Fig. 1, the fuses serving to protect the instrument from a heavy current; the carbon blocks, with their fusible plugs and ground connection to the center carbon, serve to afford an easy path to ground for the high-tension current which results from lightning discharges or from crosses with high-tension transmission lines.

Where a protector is employed, the wiring from the protector to the instrument is preferably done with twisted pairs which may be covered with an insulation to conform with the woodwork of the interior and thus avoid the unsightly appearance of two black wires. Where the line is led directly to the instrument, the twisted pair is spliced to the entering wires as close as possible to the point of entrance. A loop should be made in each conductor, on the outside of the building, the bottom of the loop hanging below the point of entrance to the hard rubber tubing; this feature affords a low point in the system from which rain water can readily drip and by means of which the passage of such water along the wire and its subsequent entry into the sub-station is avoided.

The efficiency of the protector depends to a very great extent upon the care and thoroughness with which the ground connection is made, and as a good ground is in most cases an easy thing to procure the connection should certainly receive careful attention. Probably the best means of making a connection of this kind in a sub-station is to run the ground wire from the protector to a water pipe. Carefully clean the outer surface of the pipe and wrap it with eight or ten turns of No. 16 bare copper

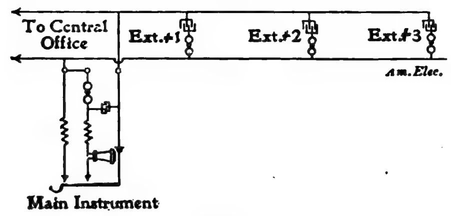


FIG. 2.

wire, the wire being soldered to the pipe wherever it is possible to do so. To the end of this coil the ground lead from the protector is spliced. It is very rare indeed that trouble arises from a connection of this kind. Where it is not possible to connect to a water pipe, a satisfactory ground may be obtained by connecting the lead from the protector to a copper plate or coil of copper wire buried in the ground at a depth of about three feet, care being taken to secure a place where there is some liability of continual dampness.

In the sub-station itself, there are many possible combinations and arrangements of instruments, which add to the satisfaction of the subscriber and to the efficiency of the telephone service from the standpoint of the user. The combinations and arrangements mentioned of course refer to the use of extension instruments or extension bells in connection with the main instrument on the exchange line. Where it is considered desirable that all telephone calls incoming to the sub-station should be answered from one point, but where the location of the instrument makes it necessary that the ringing of the telephone bell should be audible at a point remote from the telephone, the extension bell will serve every purpose, and for all practical purposes an unlimited number of extension bells may be connected on a sub-station line. The usual method of connecting these bells in the circuit is shown by the diagram in Fig. 2. In this instance a main instrument and three extension bells are shown connected to the circuit. The bells themselves are of the same type as the bell on the main instrument and are connected in parallel across the line circuit,

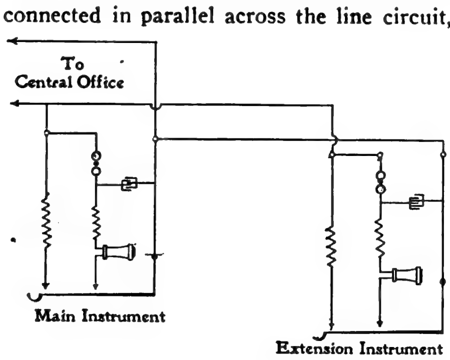


FIG. 3.

a switch usually being inserted in the branch circuits in order that the extensions may be rendered inoperative at will. It is, of course, apparent that by increasing the number of bells which are permanently bridged across the line, the resistance of the circuit will be decreased. The amount of current, however, which flows through each bell remains the same, whether there be two or ten extensions on the line. There are a great many ways of connecting extension instruments in order that calls to the station may be answered over any instrument at will, and in order also that any one of the instruments may be capable of being directly connected with the central office. In addition to these features, the circuits are oftentimes so arranged that the extensions may call the main instrument without the medium of the central office.

The simplest method of connecting extension instruments is shown in Fig. 3. Here the extension is bridged directly across the line; both the extension and main instruments being provided with bells, so that calls from the central office may be received on either instrument and the central office may be reached from either the extension or main station. There is nothing in this method of connecting instruments which limits the number that may be connected to a single line. There is, however, one feature which may at times prove disadvantageous, since the conversation which is being carried on at one instrument may be overheard at the other. Fig. 4 shows diagrammatically the same method of connecting the instruments except that the extension instead of being directly bridged across the line is connected by a switching key at the main instrument, so that when it is desirable the extension instrument may be entirely cut off from the line, while any

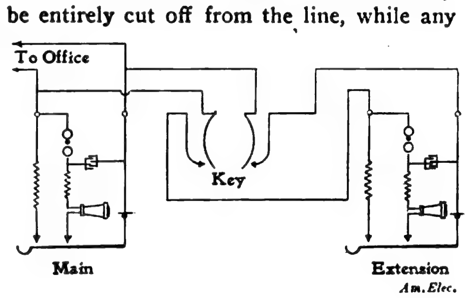


FIG. 4.

connection originating at the extension may be supervised from the main instrument.

It is not the usual practice for telephone companies to install extension instruments which are connected in such a way that conversation may be carried on between the main and extension instruments other than through the central office, but cases may arise where it is desirable to depart from this general rule, and a convenient method of accomplishing this end is shown in Fig. 5.

In this diagram it will be observed that the line from the central office is led to the instruments through the contacts of a switching key which is normally arranged so that the instruments are disconnected from the line, but at the same time, signals may be received at the main station through the bell which is bridged across the entering line from the central office and which has a condenser inserted in series with it. The operation of this arrangement will be easily understood. On an incoming call the signal is given by the perma-

nently bridged bell, and by throwing the switching key to the outer contacts the subscriber at the main instrument is placed in connection with the operator at the central office and the call may be received. Should the person desired be more conveniently reached at the extension station, it is only necessary for the person at the main instrument to request the operator to ring over the line, at the same time replacing the receiver of the main instrument on the hook. When the operator rings, the bells at both stations are actuated and the desired connection readily obtained. As previously stated, the normal position of the switching key is that with the line to the central office disconnected from the instruments. When this condition is obtained the diagram shows that the battery, the terminas of which are connected to the inner contacts of the key, is bridged across the line, thus connecting the two stations. Should one station desire to signal the other, the operation of the hand generator causes a current to flow through the bell of the station desired and makes the connection possible. The ringing current in this instance is prevented from finding its return circuit through the battery by means of the impedance coils, one of which is connected on either side of the source of current supply. These coils are of low resistance, but are wound with a number of turns on an iron core and have in consequence a high impedance to the alternating ringing current and prevent the circuit from being completed through the battery when the called station has responded to the signal.

It will be noted that the talking circuit between the two instruments is of the simplest character and comprises a direct line between the two stations with a battery bridged across it. The advantages of this arrangement for some sub-stations lie in the fact that the extension instrument is at all times under the control of the main station, that no calls for outside points can originate except with the knowledge of the subscriber at the main instrument, and that communication may be quickly and readily obtained between the two stations. It follows very naturally that in but rare cases two extension instruments are the maximum number which are connected to a single line: the reason for this is a two-fold one. In the first place, where the necessity exists for more than three instruments in a sub-station there is usually a considerable use of the line, and consequently, the liability is great that two stations may desire to obtain connections at the same time, thus delaying calls. In the second place, the operating telephone companies are desirous of increasing their traffic as much as possible and avoiding lost or delayed calls. In cases where it might be possible to consider the installation of a larger number of extension instruments it is the policy of the telephone companies to recommend and insist upon the use of private branch exchanges, which permit of easy intercommunication between the extension stations and, at the same time, provide for more than one connecting trunk line to the central office.

As the requirements of a sub-station increase the utility and advantages of the private branch exchange as an auxiliary to the central office become more and more apparent, and with the present conditions which govern the devlopment of the telephone sub-station the private branch exchange may unquestionably be considered as the limit towards which the sub-station is constantly tending.

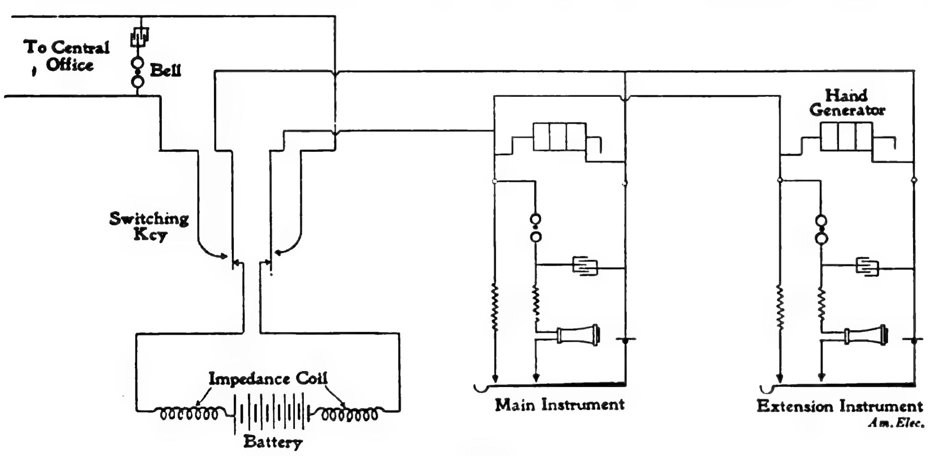


FIG. 5.

GENERATOR COMMUTATOR REPAIRS.

BY ARTHUR B. WEEKS.

When a suspicious spark begins to manifest itself on a generator commutator, the cause should be sought at once. The construction of some generator connections is such, that the flat connecting strips are free to vibrate, and sooner or later they begin to weaken and finally break off. The sparking commences with the make and break of the connection, and if not discovered and repaired, the commutator will require turning. If a wooden wedge be used to pry slightly between the vertical connections in line with a bar which shows any discoloration, the fault will usually be located at once. Undue prying, however, is injurious and must be avoided. The trouble should be located as speedily as possible. It should not be laid to a bad brush, and ignored, but the machine should be shut down as soon as convenient and the trouble investigated.

The connection usually breaks at the surface of the commutator, as at *A*, Fig. 1. The connector lugs of strip copper are frequently separate from the commutator bars and are riveted and soldered in place. They open out at the top to admit the arma-

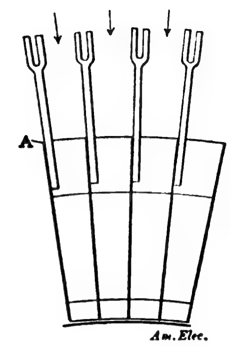
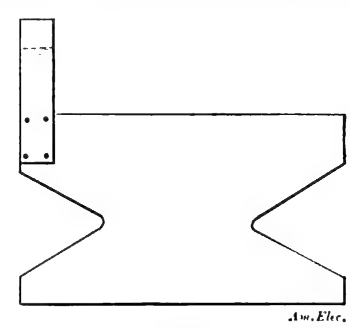


FIG. 1.

ture conductors, the number depending upon the system of winding. Fig. 2 shows a side view of a commutator bar and an attached lug.

To repair such a break requires judgment and skill in the use of a chisel. The first thing to be done is to push asbestos in between adjacent bars, so that heat from the torch will not affect them. Asbestos should also be worked in at the back if possible, for the purpose of keeping solder from places where it would cause trouble. Then unsolder the armature leads from the lug and remove the latter. Next, with specially made cape chisels, cut a slot in the commutator bar for a new lug. Great care and skill are required not to destroy the mica insulation between the segments. The slot should be cut one-quarter to three-eighths inch deep. The connector is then soldered in place.

With care a satisfactory connection can be made in this way, which will last well.



FIV. 2.

If it does not last, the trouble in almost every case is due to poor soldering. Short circuits sometimes occur after this operation, because of solder falling in at the back and lodging on lower connections. In large machines, especially rotary converters, the excessive current flowing is quite likely to melt this solder, and the machine may buck, throwing out the melted solder, after which it may be all right again. While the bar connector is out, however, asbestos should be packed in back of it to prevent this occurrence, which may be a serious affair.

All surplus solder and the asbestos packing should be removed after the connection is finished, and the connections cleaned with compressed air. The armature should be turned over slowly, air being applied all the while. Even this may not remove all solder, and things may be running along nicely, when a sudden great flash at the brushes occurs, and melted solder is found on the generator frame in line with the commutator connections.

Fig. 3 shows an armature of this kind, which has just been rewound, the band

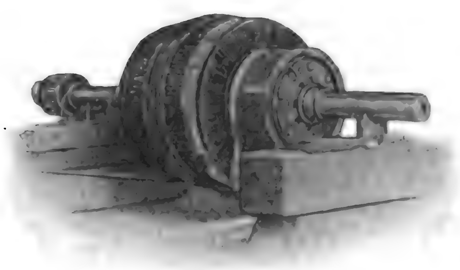


FIG. 3.—ARMATURE OF ROTARY CONVERTER.

wires being put on while the armature is turned by means of a hand winch. A rope from the winch is wound around the armature several times, as shown, and the winch lever turned, giving motion to the armature.

Before soldering the armature leads into the radial commutator lugs, tapered hardwood wedges should be driven in between the connectors all around the armature, as indicated by the arrows in Fig. 1. The soldering flux is then applied, and the solder put on with torches. Before connecting and soldering, a piece of cloth should be arranged back of the commutator to catch surplus solder, and when the work is completed, this can be drawn out between the spider legs at the back, by means of strings previously fastened to the cloth and passed out at the back of the armature.

After soldering the excess solder is turned off when the armature is replaced in the machine, or swung in a lathe. Of course, in its present condition, current cannot be applied to turn it. If it is the armature of a rotary converter, which is true of the one illustrated, the starting motor can drive it. The wedges are then removed. Finish the connections finally with a good black air-drying insulating paint.

ECONOMY OF FEED-WATER HEATING.

It is, of course, a matter of common knowledge among steam engineers that heating the feed-water of a boiler before delivery into the boiler effects a considerable saving in fuel, or, what amounts to the same thing, enables the boiler to evaporate more water per pound of coal. The percentage of increase in water per pound of coal is not the same as the percentage of decrease in coal per pound of water, but the difference is usually small. For example, if the amount of water evaporated per pound of coal is 10 per cent. greater by heating the feed-water, the reduction in coal per pound of water evaporated is not 10 per cent., but 9 per cent., or, academically, 9.1919 per cent.

A table of factors of evaporation furnishes a most convenient means of estimating the saving in fuel or the increase in steaming capacity due to heating the feed-water. In order to ascertain approximately the saving in fuel it is only necessary to divide the factor of evaporation corresponding to the conditions of heated feed-water by the factor corresponding to the conditions with unheated feed and multiply the result by the coal consumption with unheated feed. For example, if a boiler is operated at 120 lbs. gauge pressure with unheated feed-water at a temperature of 70° Fahrenheit, the factor of evaporation is 1.1915; if the feed-water were heated to 200° Fahrenheit, the factor would be 1.0561. Dividing this last factor by the first one gives 0.886, so that the coal per pound of water with feed-water at 200° Fahr. would be 0.886 × the coal per pound of water with feed-water at 70° Fahr. Or, if the coal consumption under existing load conditions is 10 tons per day, the amount burned with the feed-water heated to 200° Fahr. would be only 8.86 tons per day.

Again, if the feed-water is heated by exhaust steam from auxiliaries which is insufficient to get the temperature above 150° Fahr., for example, and the working boiler pressure is 120 lbs. per sq. in., the evaporation factor will be 1.1083. If by decreasing the efficiency of the auxiliaries their steam consumption would be increased so that their exhaust steam would heat the feed-water up to 210° Fahr., the factor then would be 1.0456, and the required fuel would be $1.0456 \div 1.1083 = 0.943$ of the quantity burned with the lower feed-water temperature. Whether or not it would pay to use less efficient auxiliaries, therefore, would depend on the cost of coal, and also on the efficiency of the feed-water heater to some extent. This problem is quite a complex one, and not within the scope of the present article, the object of which is merely to point out the application of the table of factors of evaporation to the question of fuel saving by feed-water heating.

If one should desire to reverse the problem and ascertain the increase in water that can be evaporated per pound of coal it is only necessary to reverse the relationship of the two evaporation factors; that is to say, divide the larger factor by the smaller and multiply the result by the present water evaporation to find the water that could be evaporated per pound of coal with the higher feed-water temperature.

FACTORS OF EVAPORATION.

Temp. of Feed.	Boiler Gauge Pressure; Pounds Per Square Inch.																			Temp. of Feed.
	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	150	160	
50	1.1987	1.2002	1.2016	1.2028	1.2040	1.2051	1.2062	1.2073	1.2082	1.2093	1.2103	1.2113	1.2122	1.2131	1.214	1.2148	1.2156	1.2171	1.2186	50
55	1.1935	1.1949	1.1963	1.1976	1.1988	1.1999	1.2010	1.2021	1.2032	1.2042	1.2052	1.2061	1.207	1.2079	1.2088	1.2097	1.2105	1.212	1.2135	55
60	1.1884	1.1898	1.1911	1.1924	1.1936	1.1948	1.1959	1.197	1.198	1.199	1.2	1.2009	1.2018	1.2027	1.2036	1.2044	1.2052	1.2068	1.2083	60
65	1.1832	1.1846	1.1859	1.1872	1.1884	1.1896	1.1907	1.1918	1.1928	1.1938	1.1948	1.1957	1.1966	1.1975	1.1984	1.1993	1.2001	1.2016	1.2031	65
70	1.178	1.1794	1.1807	1.182	1.1832	1.1844	1.1855	1.1866	1.1876	1.1886	1.1896	1.1906	1.1915	1.1924	1.1933	1.1941	1.1949	1.1964	1.1979	70
75	1.1728	1.1742	1.1755	1.1768	1.1780	1.1792	1.1803	1.1814	1.1824	1.1834	1.1844	1.1853	1.1862	1.1871	1.188	1.1889	1.1897	1.1912	1.1927	75
80	1.1676	1.169	1.1703	1.1716	1.1728	1.174	1.1751	1.1762	1.1772	1.1782	1.1792	1.1802	1.1811	1.182	1.1829	1.1837	1.1845	1.1860	1.1875	80
85	1.1624	1.1638	1.1652	1.1665	1.1677	1.1688	1.1699	1.171	1.172	1.1730	1.174	1.175	1.1759	1.1768	1.1777	1.1785	1.1793	1.1809	1.1824	85
90	1.1572	1.1586	1.16	1.1613	1.1625	1.1636	1.1647	1.1658	1.1669	1.1679	1.1689	1.1698	1.1707	1.1716	1.1725	1.1733	1.1741	1.1757	1.1772	90
95	1.152	1.1534	1.1548	1.1561	1.1573	1.1584	1.1595	1.1606	1.1617	1.1627	1.1637	1.1646	1.1655	1.1664	1.1673	1.1681	1.1689	1.1705	1.172	95
100	1.1469	1.1483	1.1496	1.1509	1.1521	1.1533	1.1544	1.1555	1.1565	1.1575	1.1585	1.1594	1.1603	1.1612	1.1621	1.1629	1.1637	1.1653	1.1668	100
105	1.1417	1.1431	1.1444	1.1457	1.1469	1.1481	1.1492	1.1503	1.1513	1.1523	1.1533	1.1542	1.1551	1.156	1.1569	1.1578	1.1586	1.1601	1.1616	105
110	1.1365	1.1379	1.1392	1.1405	1.1417	1.1429	1.144	1.1451	1.1461	1.1471	1.1481	1.149	1.1499	1.1508	1.1517	1.1526	1.1534	1.1549	1.1564	110
115	1.1313	1.1327	1.134	1.1353	1.1365	1.1377	1.1388	1.1399	1.1409	1.1419	1.1429	1.1438	1.1447	1.1456	1.1465	1.1473	1.1481	1.1496	1.1512	115
120	1.1261	1.1275	1.1288	1.1301	1.1313	1.1325	1.1336	1.1347	1.1357	1.1367	1.1377	1.1386	1.1395	1.1404	1.1413	1.1422	1.143	1.1445	1.146	120
125	1.1209	1.1223	1.1236	1.1249	1.1261	1.1273	1.1284	1.1295	1.1306	1.1316	1.1325	1.1334	1.1343	1.1352	1.1361	1.1370	1.1378	1.1393	1.1408	125
130	1.1157	1.1171	1.1184	1.1197	1.1209	1.1221	1.1232	1.1243	1.1253	1.1263	1.1273	1.1282	1.1291	1.1300	1.1309	1.1318	1.1326	1.1341	1.1356	130
135	1.1105	1.1119	1.1132	1.1145	1.1157	1.1169	1.118	1.1191	1.1201	1.1211	1.1221	1.123	1.1239	1.1248	1.1257	1.1266	1.1274	1.1289	1.1304	135
140	1.1052	1.1066	1.108	1.1093	1.1105	1.1117	1.1128	1.1139	1.1149	1.1159	1.1169	1.1178	1.1187	1.1196	1.1205	1.1214	1.1222	1.1237	1.1252	140
145	1.1	1.1014	1.1028	1.1041	1.1053	1.1065	1.1076	1.1087	1.1097	1.1107	1.1117	1.1126	1.1135	1.1144	1.1153	1.1161	1.1169	1.1185	1.12	145
150	1.0948	1.0962	1.0976	1.0988	1.1	1.1012	1.1024	1.1035	1.1045	1.1055	1.1065	1.1074	1.1083	1.1092	1.1101	1.1109	1.1117	1.1133	1.1148	150
155	1.0896	1.091	1.0924	1.0936	1.0948	1.096	1.0971	1.0982	1.0992	1.1002	1.1012	1.1022	1.1031	1.104	1.1049	1.1057	1.1065	1.1081	1.1096	155
160	1.0844	1.0858	1.0872	1.0884	1.0896	1.0908	1.0919	1.093	1.094	1.0951	1.096	1.097	1.0979	1.0988	1.0996	1.1005	1.1013	1.1029	1.1044	160
165	1.0792	1.0806	1.0819	1.0832	1.0844	1.0856	1.0867	1.0878	1.0888	1.0898	1.0908	1.0918	1.0927	1.0936	1.0945	1.0953	1.0961	1.0977	1.0992	165
170	1.074	1.0754	1.0767	1.078	1.0792	1.0804	1.0815	1.0826	1.0836	1.0846	1.0856	1.0865	1.0874	1.0883	1.0892	1.0901	1.0909	1.0924	1.094	170
175	1.0687	1.0701	1.0715	1.0728	1.074	1.0752	1.0763	1.0774	1.0784	1.0794	1.0804	1.0813	1.0822	1.0831	1.084	1.0848	1.0856	1.0872	1.0888	175
180	1.0635	1.0649	1.0663	1.0675	1.0687	1.0699	1.071	1.0721	1.0732	1.0742	1.0752	1.0761	1.077	1.0779	1.0788	1.0796	1.0804	1.082	1.0836	180
185	1.0583	1.0597	1.061	1.0623	1.0635	1.0647	1.0658	1.0669	1.0679	1.0689	1.0699	1.0709	1.0718	1.0727	1.0736	1.0744	1.0752	1.0768	1.0783	185
190	1.053	1.0544	1.0558	1.0571	1.0583	1.0595	1.0606	1.0617	1.0627	1.0637	1.0647	1.0656	1.066	1.0674	1.0683	1.0692	1.07	1.0716	1.0731	190
195	1.0478	1.0492	1.0506	1.0519	1.0531	1.0542	1.0553	1.0564	1.0575	1.0585	1.0595	1.0604	1.0613	1.0622	1.0631	1.0639	1.0647	1.0663	1.0679	195
200	1.0426	1.044	1.0453	1.0466	1.0478	1.049	1.0501	1.0512	1.0522	1.0532	1.0542	1.0552	1.0561	1.057	1.0579	1.0587	1.0595	1.0611	1.0626	200
202	1.0405	1.0419	1.0432	1.0445	1.0457	1.0469	1.048	1.0491	1.0501	1.0511	1.0521	1.0531	1.054	1.0549	1.0558	1.0566	1.0574	1.0590	1.0605	202
204	1.0384	1.0398	1.0411	1.0424	1.0436	1.0448	1.0459	1.047	1.048	1.049	1.05	1.051	1.0519	1.0528	1.0537	1.0545	1.0553	1.0569	1.0584	204
206	1.0363	1.0377	1.039	1.0403	1.0415	1.0427	1.0438	1.0449	1.0459	1.0469	1.0479	1.0489	1.0498	1.0507	1.0516	1.0524	1.0532	1.0548	1.0563	206
208	1.0342	1.0356	1.0369	1.0382	1.0394	1.0406	1.0417	1.0428	1.0438	1.0448	1.0458	1.0468	1.0477	1.0486	1.0495	1.0503	1.0511	1.0527	1.0542	208
210	1.0321	1.0335	1.0348	1.0361	1.0373	1.0385	1.0396	1.0407	1.0417	1.0427	1.0437	1.0447	1.0456	1.0465	1.0474	1.0482	1.049	1.0506	1.0522	210
212	1.03	1.0314	1.0327	1.0340	1.0352	1.0364	1.0375	1.0386	1.0396	1.0406	1.0416	1.0426	1.0435	1.0444	1.0453	1.0461	1.0469	1.0485	1.0501	212

American Electrochemical Society.—The next annual meeting of the American Electrochemical Society will be held at Boston and Cambridge, Mass., April 25, 26 and 27. The program will include papers by Dr. J. W. Richards, Dr. H. S. Carhart, Dr. W. D. Bancroft, Dr. Carl Hambuechen, Prof. Blake, Prof. H. R. Carveth, Arvid A. Reuterdahl and C. G. Richardson. A number of excursions will be held and some interesting exhibits will be made at the convention headquarters. The hotel headquarters will be The Lenox, Boyleston and Exeter Streets, Boston, Mass.

DISEASES OF ELECTRICAL MACHINERY.

BY F. B. CROCKER AND S. S. WHEELER.

The promptness with which a difficulty with electrical machinery may be overcome will always have much to do with the success of the plant. The following statement of troubles or "diseases," with their symptoms and remedies for the various types of generators and motors, has been prepared to facilitate the detection and elimination of these troubles. It is evident that the subject is somewhat complicated and difficult to handle in a general way, since much depends upon the particular conditions in any given case, each of which must be stated in such a way as to distinguish it from all others. Nevertheless, a great deal can be covered by systematic treatment. It may frequently happen that a trifling oversight, such as allowing a wire to slip out of a binding-post, will cause as much annoyance and delay in the use of electrical machinery as the most serious accident. Other troubles, equally simple but not so easily detected, may also occur. In such cases even a slight knowledge on the part of the man having the machine in charge, guided by a correct set of rules, will enable him to overcome the difficulty immediately and save much time, trouble and expense. The principal object should always be to separate clearly the various causes and effects from each other. A careful and thorough examination should be first made, and as far as possible one should be sure of the facts, rather than attempt to guess what they are and jump at conclusions. Of course general precautions and preventive measures should be taken *before* any troubles occur, if possible, rather than wait until a difficulty has arisen. For example, one should see that the machine is not overloaded and should make sure that the oil-cups are not empty. Neglect and carelessness with any machine are usually and deservedly followed by accidents of some sort.

A. Sparking at the Commutator.

This is a common trouble that is not very objectionable if moderate in amount and duration. Beyond these limits, however, it is likely to become serious because it burns and roughens the commutator, thus aggravating the difficulty. At the same time it produces heat that may spread to and injure the armature or bearings. Any machine having a commutator is liable to spark, including practically all direct current and some alternating current machines. Most alternating current machines have collecting rings which are not likely to spark; but rotary converters, self-exciting or composite wound alternators, as well as series and other types of self-starting, single-phase motors, require a commutator which may spark. This trouble can be prevented in most cases by proper design and construction. The inductance per section must be limited by correct form of slot, sufficient number of sections and strength of magnetic field. Carbon brushes also tend to reduce sparking. A certain amount of sparking occurs normally in most constant-current dynamos for arc lighting, where it is not very objectionable, since they are designed to stand it, and the current is small.

Cause 1.—Armature carrying too much current, due to (*a*) overload (for example, too many lamps fed by a generator, or too much mechanical work done by a motor); a short circuit, leak or ground on the line may also have the effect of overloading a generator; (*b*) excessive voltage on a constant-potential circuit or excessive amperage on a constant-current circuit. In the case of a motor any abnormal friction due to the armature striking or rubbing against the

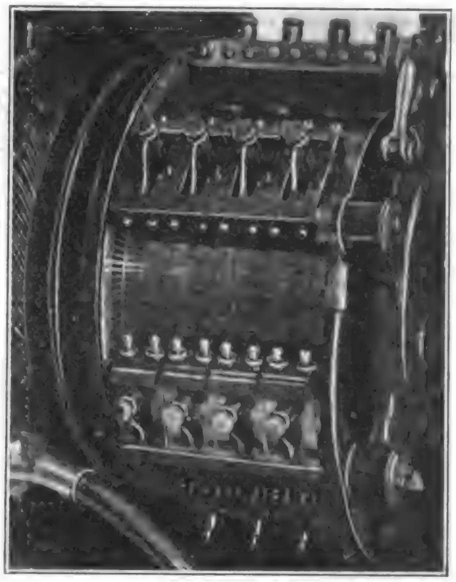


FIG. 1.—COMMUTATOR IN GOOD CONDITION.

pole pieces, or the shaft not turning freely will have the same effect as an overload. It often happens, especially with a new machine, that an overload, short-circuit, etc., creates a very excessive current. This may produce, even if only momentary, a burned and rough spot on the commutator.

Symptom.—If the excessive current flows for any considerable time the whole armature becomes overheated. The belt (if used) is very tight on tension side, sometimes squeaking, because it slips on the pulley. Overload, due to friction, may be detected by stopping the machine, and if not too large, turning it slowly by hand or with a lever, the load being disconnected. A convenient and sensitive test for any size of machine is to determine the current required to run the armature free (operating as a motor), which should not be more than about 4 or 5 per cent. of the current at rated load, except in machines of 10 horse-power or less, which may take 6 to 10 per cent. The field current should be measured first, with the armature circuit open, and deducted from the ammeter reading. (See "Heating of Bearings" and "Noise.")

Remedy.—(*c*) Reduce the load, or eliminate the short circuit, leak, or ground on the line; (*d*) decrease the size of driving pulley, or (*e*) increase the size of driven pulley; (*f*) decrease magnetic strength of the field in the case of a dynamo or increase it in the case of a motor. If excess of current cannot satisfactorily be overcome in any of the above ways, it will probably be necessary to change the machine or its winding. Overload due to friction is eliminated as described under "Heating of Bearings" and "Noise," Cause 2.

If the starting or regulating rheostat of a motor has too little resistance, it will cause the motor to start very suddenly and spark badly at first. The only remedy is to increase this resistance.

Cause 2.—Brushes not set at the neutral point.

Symptom.—Sparking varied by shifting the brushes with rocker arm or ring.

Remedy.—Carefully shift the brushes backwards or forwards until sparking is reduced to a minimum. If only slightly out of position, heating alone may result, the conditions not being bad enough to show sparking. If the brushes are not exactly opposite, or in a four-pole machine 90° apart, and so on, they should be made so, the proper points of contact being determined by counting the commutator-bars, by measuring with a strip of paper, or by separately adjusting each set of brushes to its minimum sparking point.

The usual position for the brushes is opposite the spaces between the pole pieces, but in some machines the brushes must be set in some other position which can be determined by finding the non-sparking or minimum sparking points. If the brushes are placed exactly wrong, namely, half-way toward the proper position for the next set of brushes, they will cause a dynamo to fail to generate and a motor to fail to start, and in the latter case the fuse will blow or the circuit-breaker open.

See "Dynamo Fails to Generate," Cause 6.

Cause 3.—Commutator rough, eccentric or has one or more "high bars" projecting beyond the others, or one or more flat bars, commonly called "*flats*," or *projecting mica*, any one of which will interfere with good

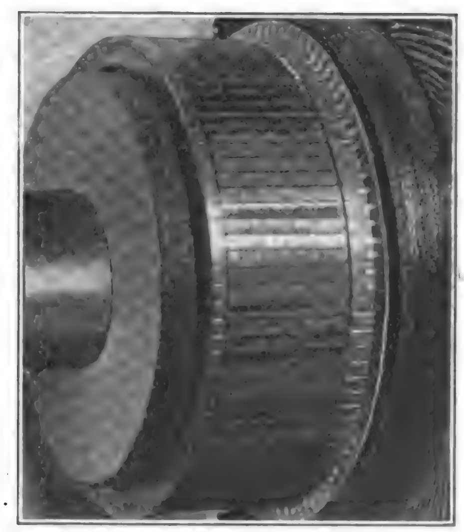


FIG. 2.—COMMUTATOR HAVING HIGH MICA AND BLACKENED BARS.

contact of the brushes or cause them to be thrown out of contact with the commutator (Fig. 2). Flat or high bars in machines usually result from looseness of the nut or screws which hold the commutator parts together. The effect of eccentricity may be produced by the shaft being loose in the bearings while the commutator is perfectly true on shaft. This will allow the whole ar-

mature to chatter when running at full speed. Hard mica between the bars which does not wear as rapidly as the copper will tend to throw the brushes off.

Symptom.—Note whether there is a glaze or polish on the commutator, which shows smooth working; touch the revolving commutator with tip of finger-nail and the least roughness is perceptible, or feel of the brushes to see if there is any jar. If the machine runs at high voltage (over 250) the commutator or brushes should be touched with a small stick or quill to avoid danger of shock. In the case of an eccentric commutator, careful examination shows a rise and fall of the brush when the commutator turns slowly, or a chattering of the brush when running fast. Sometimes by sighting in line with brush contact one can see daylight between the commutator and brush, because the latter jumps up and down.

Remedy.—Smooth the commutator with a fine file or fine sandpaper, the latter being applied by a block of wood which exactly fits the commutator. Carborundum paper or a carborundum hone is also applicable, but *emery should never be used.* In all cases

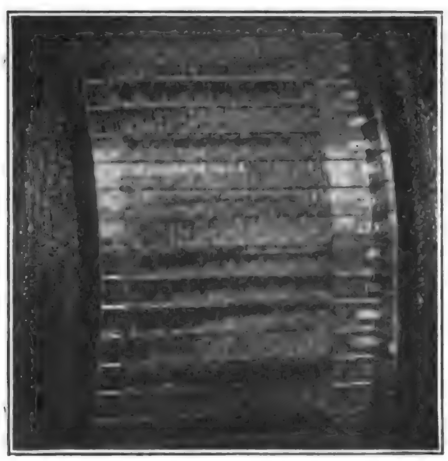


FIG. 3.—BURNED COMMUTATOR.

particles of grit or copper should be very carefully removed before the brushes are allowed to touch the commutator. To set up a loose nut on a commutator requires considerable force, a long wrench being used. The effective length of a wrench may be increased by slipping over the handle a piece of iron pipe. Screws may be tightened by means of a heavy screw-driver. If the bearing is loose, put in a new one. If the commutator is very rough or eccentric, the armature should be taken out, put in a lathe, and the commutator turned off. Large machines may be provided with a slide-rest attachment or grinding device, so that the commutator can be turned off or ground true without removing the armature. This is clamped on the pillow-block or rocker ring.

For turning off a commutator, a diamond-pointed tool should be used, with a very sharp and smooth edge, only an exceedingly fine cut being taken off each time in order to avoid catching in or tearing the copper, which is very tough. The surface is then finished by applying a "dead smooth" file while the commutator revolves rapidly in the lathe. Any particles of copper should then be carefully removed from between the bars.

In order to have the commutator wear smooth and work well, it is desirable to have the armature shaft move freely back and forth about an eighth of an inch in the bearings, but in some machines this is not practicable. A commutator should have a dull glaze of a brown or bronze color. A very bright or scraped appearance does not indicate the best condition. Sometimes it is desirable to apply a very little vaseline or a drop of oil to a commutator which tends to become rough. Much oil is very bad, and causes the following trouble.

Cause 4.—Brushes make poor contact with commutator.

Symptom.—In general, all of the cases under Cause 3 will have this effect, but the two classes are usually distinguishable. Close examination shows that brushes touch only at one corner, or only in front or behind, or there is dirt on the surface of contact. Sometimes, owing to the presence of too much oil or from other causes, the brushes and commutator become very dirty, and covered with smut. They should then be carefully cleaned by wiping with a slightly oily rag or one moistened with benzine, or by other means. In some cases a commutator becomes sticky, which causes the brushes to "chatter," and, therefore, to make poor contact.

Occasionally a "glass-hard" carbon brush is met with. It is incapable of wearing to a good seat or contact, and will touch only at one or two points. Some carbon brushes are of abnormally high specific resistance, so that they do not make good electrical contact. In both cases new brushes should be substituted. Vibration (Sparking, Cause 10), also interferes with good brush contact.

Remedy.—Carefully clean the commutator, also fit, adjust and clean the brushes until they rest evenly on the commutator, with the maximum surface of contact and with sure but not too heavy pressure. In order to fit copper brushes properly on the commutator, a brush jig is required. Carbon brushes may be fitted perfectly by drawing a strip of sandpaper back and forth between them and the commutator while they are pressing down. A band of sandpaper may be pasted or tied around the commutator, and the armature slowly revolved by hand or by power and the brushes pressed upon the commutator.

It sometimes happens that the brushes make poor contact, because the brush-holders do not work freely.

Cause 5.—Short-circuited or reversed coil, or coils in the armature.

A short-circuit is often called a "short" and sometimes a "cross." The former term, however, applies properly to an accidental connection between conductors belonging to the same circuit, while the latter is applied to an accidental contact between two separate lines or circuits. A "flying" short-circuit is one that exists only when the machine is running, being caused by centrifugal force.

Symptom.—A motor will draw excessive current, even when running free without load. A generator will require considerable power, even without any external load. For reversed coil see "Heating of armature," Cause 6.

The short-circuited coil is heated much more than the others, and is very apt to be burned out entirely; therefore, the machine should be stopped immediately. If it is necessary to run the machine to locate the short-circuit, one or two minutes is long enough, but may be repeated until the short-circuited coil is sufficiently warmed to be found by feeling the entire surface of the armature.

A screw-driver or other iron or steel tool held between the pole pieces near the revolving armature vibrates very perceptibly as the short-circuited coil passes. Almost any armature, particularly one with teeth, will cause a slight but rapid vibration of a piece of iron held near it, but a short-circuit produces a much stronger effect only *once* per revolution. Care should be taken not to allow the piece of iron to be drawn in and jam the armature.

The current pulsates and the torque is unequal at different parts of a revolution, these being particularly noticeable when several coils are short-circuited or reversed and the armature turns rather slowly. If a large portion of the armature is short-circuited the heating is distributed and more difficult to locate. In this case a motor runs very slowly, giving little power, but having full field-magnetism. A short-circuited coil can also be detected by the drop-of-potential method. (For generators, see "Dynamo Fails to Generate," Cause 3.)

A "flying" short-circuit may not have any effect when the armature is standing still. It can often be forced to show itself momentarily, by pounding the armature core or the end of the shaft with a mallet or stick of wood. It is detected by the drop-of-potential method which would indicate intermittent variations in resistance.

Remedy.—A short circuit is often caused by a piece of solder or other metal getting between the commutator bars or their connections with the armature, and sometimes the insulation between or at the ends of these bars is bridged over by a particle of metal. In any such case the trouble is easily found and corrected. If, however, the short-circuit is in the coil itself, the only effective remedy is to rewind the coil.

One or more "grounds" in the armature may produce effects similar to those arising from a short-circuit. (See Cause 7.)

Cause 6.—Broken circuit in the armature.

Symptom.—Commutator flashes violently while running, and the commutator bar nearest the break is badly cut and burned; but in this case no particular armature coil will be heated as in the last case (Cause 5), and the flashing will be very much worse, even when turning slowly. This trouble, which might also be confounded with a bad case of "high bar" in, or eccentricity of the commutator ("Sparking," Cause 3), is distinguished therefrom by slowly turning the armature, when violent flashing will continue if the circuit is broken, but not with an eccentric commutator or even with a "high bar," unless the latter is very bad, in which case it is easily felt or seen. A very bad contact at some point would have almost the same effect as

a break in the circuit. In the case of a so-called "flying break" the circuit is only open when the machine is running, the effect of centrifugal force.

Remedy.—A break or bad contact may be located by the "drop" method or by a continuity test, while the armature is not running. Under these conditions a "flying break" does not manifest itself, but may be made to do so momentarily by pounding the armature core or the end of the shaft with a mallet or stick of wood, as in Cause 5. The trouble is most often found where the armature wires connect with the commutator, and not in the coil itself, and the break may be repaired or the loose wire properly connected and fastened. When the trouble is due to a broken commutator connection, which cannot be repaired immediately, the disconnected bar may be temporarily connected to the next by solder; or the brushes may be "staggered" by putting one forward or the other backward so as to bridge over the break. It may be impracticable to "stagger" radial brushes, but usually a brush is thick enough to make contact with more than one commutator bar. If the break is in the coil itself, rewinding is generally the only cure. But this may be remedied temporarily by connecting together by wire or solder the two commutator bars or coil terminals between which the break exists. It is only in an emergency that armature coils should be cut out or commutator bars connected together, or other makeshifts resorted to, but it sometimes avoids a very undesirable stoppage. A very rough but quick and simple way to connect two commutator bars is to insert a copper peg or wedge, or to force the metal of the bars together across the mica insulation at the end of the commutator. This should be avoided if possible, but if it has to be done in an emergency the bruised material can afterward be picked out and the cavity filled in with wood. In carrying out any of these methods care should be taken not to short circuit any other armature coil, which would produce sparking (Cause 5).

Cause 7.—Ground in the armature.

Symptom.—Two or more "grounds" (accidental connections between the conductors on the armature and its iron core or the shaft or spider) would have practically the same effect as a short-circuit (Cause 5), and should be treated in the same way. A single ground would have little or no effect, provided the circuit is not intentionally or accidentally grounded at some other point. On an electric railway (overhead trolley) or other circuit which employs the earth as the return conductor, or a three-wire system with the neutral conductor grounded, one or more grounds in the armature would allow the current to pass directly through them, and would cause the machine to spark and have a very variable torque at different parts of a revolution.

Remedy.—A ground may be detected by testing with a magneto bell. It may be located by the drop-of-potential method. Another way to locate it is to wrap a wire around the commutator so as to make connection with all of the bars, and then connect a source of current to this wire and to the armature shaft (by pressing a wire upon the latter). The current will then flow from the armature conductors through the ground connection and the magnetic effect of the armature winding will be localized at the point where the ground is. This point is then found by the indications of a compass needle slowly moved around the surface of the armature. The current may be obtained from a storage battery or from the circuit, but should be regulated by lamps or other resistance so as not to exceed the normal armature current. The armature core may be more or less insulated from the shaft and ground by the insulation between the laminæ, in which case one contact with the conductors would not have the effect of a ground. Sometimes the ground may be in a place where it can be corrected without much trouble, but usually the particular coil and often others have to be rewound. A ground will be produced if the insulation is punctured by a spark of static electricity, which may be generated by the friction of the belt; in fact, a belt usually gives off electric sparks while running. If the frame of the machine is connected to the earth the static charge will flow away harmlessly, but such grounding by means of a good conductor is sometimes undesirable. In those cases the frame may be connected to the earth through a Geissler tube, a wet thread, a heavy pencil-mark on a piece of unglazed porcelain, or other very high resistance which will carry off the static charge of very high potential and almost infinitesimal quantity, but will not permit the passage of any considerable current that might cause trouble. Large direct-connected machines are almost necessarily grounded.

Cause 8.—Weak magnetic field.

Symptom.—Pole pieces are not strongly magnetic when tested with a piece of iron. Point of least sparking is shifted considerably from normal position, due to relatively strong distorting effect of armature reaction. Speed of a shunt motor is usually high unless magnetism is very weak or *nil*, in which case it may run slowly, stop, or even run backwards. A generator fails to produce the full voltage or current.

The particular cause of trouble may be found as follows: A *broken circuit* in the field of a motor is found by purposely opening the field circuit at some point, taking care first to disconnect the armature (by putting wood under the brushes, for example), and to use only one hand, to avoid shock. If there is no spark when circuit is thus opened, there must be a broken circuit somewhere. Usually a *short-circuit* is confined to one magnet, and will therefore weaken that one more than the others, and a piece of iron held midway between the pole-pieces will be be attracted to one more than to the other. It may be found by the drop-of-potential or other method to determine whether one coil has considerably less resistance than any of the others. It is highly improbable that simultaneous short circuits would affect two or more coils equally. It is to be noted that a short circuit in one of the field coils, which are usually in series, causes that coil to be heated *less* than the others. *"Grounding"* is practically identical with short-circuiting, but one ground will not produce this effect until another occurs. A double ground, through which the current finds a complete circuit, is equivalent to a short-circuit. With overhead trolley electric railways a ground return is used, and the neutral conductor of three-wire systems is often grounded, in which cases one ground may be sufficient to cut out one or more field coils.

A field coil reversed and opposed to the others will weaken the field magnetism, and cause bad sparking. This may be detected by examining the field coils to see if they are all connected in the right way, or by testing with a compass needle to find whether the poles are alternately N. and S. (See "Dynamo Fails to Generate," Cause 4.) The series-coil of a compound-wound machine is often connected wrongly, and has the effect of forcing down the voltage the more the load is increased instead of raising it.

Remedy.—A broken circuit or a short-circuit or a ground is easily repaired if external or accessible. If it is internal, the only remedy is to replace or rewind the faulty coil. A shunt motor will spark badly in starting if the armature is connected before the field. This may be avoided by proper arrangement and manipulation of the switches. If the voltage is too low on the circuit, it is likely to cause sparking in a shunt generator or motor; and if it cannot be raised the resistance of the field circuit should be reduced by unwinding a few layers of wire or by substituting other coils.

To suit the speed of an engine or on account of a mistake in the size of pulleys or gearing, the speed of a generator may be higher than that at which it was designed to run. In such a case the field is necessarily weakened by means of its rheostat in order to obtain the rated voltage, thus producing a tendency to spark. The only remedy is to reduce the speed to the prescribed value. The same difficulty may occur in a shunt motor which is run above the rated speed by weakening its field. To avoid sparking it may be necessary to strengthen the field and change the pulley or gearing ratio or the speed of the driven machine to suit the diminished speed of the motor, unless the latter was specially designed to operate with weakened field in order to vary its speed. This method is now commonly employed, but is not applicable to ordinary types of shunt motor working at or near full torque. By reducing the load or current in such a machine below the rated amount, a corresponding field weakening is permissible without excessive sparking. For example, a motor intended for 40 amperes with full field may carry 30 amperes with its field weakened to give about 20 per cent. increase in speed.

These conditions apply to other commutator machines in which there is any considerable variation in field strength, such as a booster for charging storage batteries, its voltage being regulated between wide

limits by means of its field rheostat. The general fact is that the allowable current is reduced as the field is weakened.

Further information on this subject may be found under "Sparking," Cause 9; "Speed Too High or Low," "Motor Stops or Fails to Start," and "Dynamo Fails to Generate."

Cause 9.—Unequal strength of magnetic poles. This might be regarded as a special case of the preceding cause of sparking—"weak magnetic field"—but is sufficiently important and different in principle to warrant separate consideration.

Symptom.—With bipolar generators or motors, one pole carries the same flux as the other, there being only one magnetic circuit. The distribution may differ, owing to different pole shape or magnetic leakage, but is not likely to produce sparking or other trouble. In a machine having more than two poles the flux in one may be much greater or less than that in each of the others. Multipolar armature windings for generators or motors (except railway motors as stated later) are usually of the parallel or multiple-circuit type which offer as many paths for the current as there are poles. With this arrangement, the fluxes through the several poles must be exactly equal in order that equal e.m.f. shall be generated in the corresponding portions of the armature. If one pole were weaker than the others a back current would flow through that part of the armature winding even with the external circuit open, all of the positive brushes and all the negative brushes being respectively connected together so that the paths of the armature winding act in parallel.

A difference in e.m.f. of only 1 or 2 per cent. might cause the full armature current to flow, although there may be no external current. With greater differences in flux and e.m.f. this internal current may rise above the normal value and cause sparking. Fortunately this trouble tends to counteract itself, because the back current strengthens a weak pole and current in the proper direction weakens a strong one. Nevertheless, differences of this kind often exist and should be looked for when sparking occurs with little or no external current, especially in a new machine. To detect them, the brushes are disconnected from each other or when this is difficult they are all raised from the commutator and two small temporary brushes of copper leaf or wire are applied successively in the usual brush positions. These brushes being connected to a voltmeter, any difference in e.m.f. between the different portions of the armature may be determined.

Remedy.—This difference is usually due to the fact that the armature is closer to one or more poles than to the others, tending to give greater flux and e.m.f. at the former. In such a case it is usually perceptible to the eye or found by measuring with a wedge that the armature is not properly centered. This condition may be corrected by slightly shifting the bearings, but with most machines, especially when direct-connected, it is preferable to shift the field magnet. Ordinarily, this adjustment can be made by putting in or taking out sheets of iron between the lugs or feet on the field ring and the bed plate. Some machines are built with several thin sheets of iron interposed between each field core and the ring, so that adjustment of the individual poles can readily be made at any time.

When the armature gets out of center, owing to considerable wear in the bearings, the proper remedy is to renew the latter. To anticipate slight wear the armature is sometimes adjusted a little nearer the upper poles. Another way to remedy this trouble is to vary the number of turns of wire in the several field coils until the same flux is produced by each. Of course, this trouble cannot occur in a bipolar machine, not only because the fluxes are equal for the two poles, as already noted, but also because it is not possible for one path through the armature to have less e.m.f. and act as a short-circuit for the other. For the same reason, a multipolar armature with series or two-circuit winding is free from this trouble. This type of winding, however, is not generally used, except for railway motors.

Cause 10.—Vibration of the machine.

Symptom.—Considerable vibration is felt when the hand or a stick held in the hand is placed upon the machine, and the sparking decreases when the vibration is reduced. Vibration of the brushes, due to a rough or sticky commutator, is hardly sufficient to cause the whole machine to vibrate, nevertheless, reference may be made to "Sparking," Causes 3 and 4.

Remedy.—The vibration is usually due to an imperfectly balanced armature or pulley (see "Noise," Cause 1), "knocking," due to looseness of the engine parts, a bad belt (see "Noise," Cause 6), or to unsteady foundations, and the remedies for these troubles should be applied.

Any considerable vibration is likely to produce sparking, of which it is a common cause. This sparking may be reduced by increasing the pressure of the brushes on the commutator, but the vibration should be stopped by the remedies referred to above.

Iowa Telephone Association.—The Iowa Telephone Association will hold its ninth annual meeting at the Chamberlain Hotel, Des Moines, Ia., March 14, 15 and 16. The association will hold its session in one of the private dining rooms on the parlor floor. Exhibits will be made by telephone supply men and manufacturers on the fourth floor of the hotel. The occasion is expected to be a most enjoyable one, and an elaborate program is being prepared. The banquet will be held on Wednesday evening, March 15. Mr. C. C. Deering, Boone, Iowa, is the secretary of the association.

Principles of Electrical Apparatus

THE STATOR OF AN INDUCTION MOTOR.

The stationary part, or stator, of an induction motor combines the functions of a field magnet with some of those of an armature. As its windings and the current in them produce the magnetic flux which causes the rotor to revolve, it is a field magnet, but in all other repects it behaves precisely as though it were a stationary armature within which a field magnet is being revolved. On this account, instead of being provided with physical poles of the ordinary type the core is made exactly as that of an external armature would be made, except that the slots are larger, as illustrated by Fig. 1. The core is laminated, as the sectional view, Fig. 2, indicates, for precisely the reasons that armature and transformer cores are laminated.

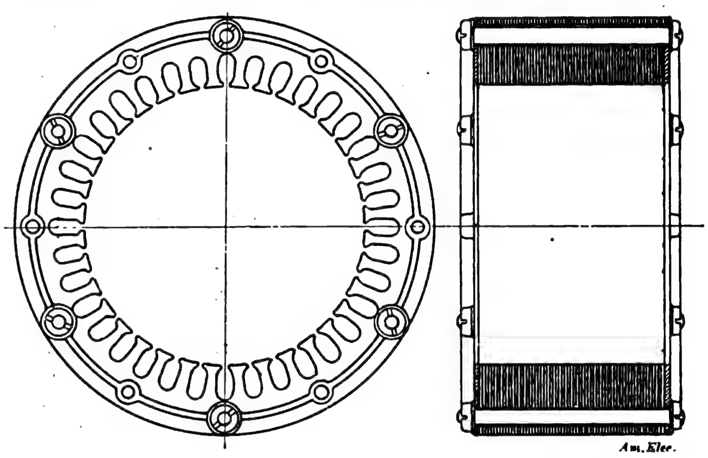


FIG. 1.—STATOR CORE OF AN INDUCTION MOTOR.—FIG. 2.

There are several other reasons why the form universally employed for the stator is preferable to the more familiar type of field magnet with projecting poles; it will perhaps suffice to give one. The windings of the rotor and those of the stator must approach as nearly as possible the conditions of the primary and secondary windings of a transformer, because their inductive relations are the same—the flux induced by the primary (stator) winding must be enclosed by the loops of the secondary (rotor) conductors to the greatest possible extent in order to give the machine good efficiency and a reasonable power factor. If the two

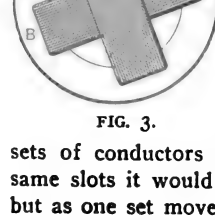


FIG. 3.

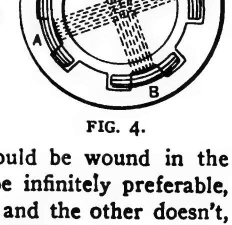


FIG. 4.

sets of conductors could be wound in the same slots it would be infinitely preferable, but as one set moves and the other doesn't, this is obviously impossible.

In order to simplify the explanation of the combined effect of two sets of field

windings supplied with two currents differing in phase, the stator of an elementary induction motor was described in a previous article as having the coils mounted as indicated in Fig. 3, which is repeated from that article for convenient reference.

Am. Elec.

FIG. 5.—BIPOLAR STATOR.

In practice, even if bipolar motors were used, the coils would not be thus mounted. Referring to Fig. 4, also repeated from the article referred to, it will be evident that the coils, A and B, can be maintained in their present positions in the stator core by simply parting the end portions and bending them around against the ends of the core, as indicated in Fig. 5, and this is what would be done in an actual machine.

As the rotating magnetic field sweeps around it is "cut" by the wires in the stator slots precisely as the wires of an alternator armature cut the lines of force of the magnetic field, and this "cutting" induces in each winding, A and B, an e.m.f. which is equal to $4.44\ \Phi\ f\ N \div 100{,}000{,}000$, in which Φ is the number of lines in the rotating magnetic field, f is the frequency of the magnetic current, and consequently the number of revolutions per second of the magnetic field (in a bipolar motor); and N is the number of complete turns in each winding. This is precisely analagous to the action of a direct-current dynamo, in which the e.m.f. generated in the armature winding is equal to $\Phi\ f\ w \div 100{,}000{,}000$. Most of the apparent discrepancy between this formula and the formula given above is due to the facts that here w, representing the wires on the armature, is used instead of N, the number of turns, and that the wires are not all in series on the armature, whereas they are so on the stator. If we consider the turns, N', on a drum armature instead of the wires, the formula becomes $E = 2\ \Phi\ f\ N' \div 100{,}000{,}000$; and if we only consider those turns, N'', that are in series with each other, it becomes

$$E = 4\ \Phi\ f\ N'' \div 100{,}000{,}000.$$

The only difference between this and the induction motor formula is that the constant is 4 instead of 4.44; the reason for this is that the wires on the stator of an induction motor are not so distributed as those on the direct-current armature, and consequently the difference in the rates at which the different wires of the winding are cutting lines of force at any given instant is much less and the total e.m.f. considerably higher. When the stator winding is more distributed, as the multiplicity of slots in Fig. 1 truthfully indicates that it is in practice, the e.m.f. induced in the winding by the rotating flux is less than the formula makes it, the correction usually being made by retaining the constant 4.44, which is fundamental, and introducing another constant representing what is usually termed the coil-breadth factor. In most two-phase motors this second constant is between 0.91 and 0.92, which is equivalent to reducing the constant 4.44 (which is a shortening of the more accurate figure, 4.442853) to 4, making the alternating current formula agree with that for a direct-current armature.

The e.m.f. induced in the stator windings by the magnetic flux opposes the e.m.f. which is applied to the stator terminals, and furnishes the counter e.m.f. of the machine. As the flux remains constant it would seem that the counter e.m.f. would be constant, which would not be logical. The reaction of the rotor upon the field, however, causes the counter e.m.f. to vary with the load. This will be discussed in a future article.

Letters on Practical Subjects

Communications intended for publication in this department must be received at this office not later than the 15th of the month prior to the date of publication.

Motor-Driven Machine Tools.

Last month's article on motors for machine tools, by Mr. Hanchett, was read with much interest and profit. However, his remarks on field control motors do not include a late type of field control which has not the disadvantage he mentions. There are motors of this type which have a range of speed of 2 to 1, without any waste of power in resistance, give full power at all speeds, do not spark, and have the advantage of operating on a two-wire system. Of all the methods of speed control the armature-resistance method is the poorest, and the multi-voltage system, where voltages as low as 50 volts are used, is almost as bad. At low voltages, an increase in power causes excessive drop in the lines. As the work done by machine tools is usually governed by the heat at the point of the tools, it follows that at slow speeds—with heavy cuts—more power can be used to advantage. Then it is an advantage to use a slow-speed motor, but at times higher cutting speeds are desired, and as the desire is to do the work as fast as possible, the same power is sometimes required at all speeds, that is, at all times, to work the machine tool to its limit. It is understood that a shunt motor is referred to. Now, if a motor will exert one horse-power at 2300 r.p.m. and also at 1200 r.p.m., it is certainly an advantage to use it, as it will be no larger than a standard motor at 1200 r.p.m. Such a motor, with field control, holds a constant speed at the point set, which is surely to be desired, since any change in the load would cause other types of motors to speed up or slow down. We are all familiar with the action of a series motor on variable loads, and this is the way (though not to the same extent) that a motor controlled by an armature resistance would act on its low speeds, taking a heavy cut. A resistance-controlled motor, if set at the right speed for a cut, will run at a lower speed when cutting; consequently, after the cut is started the speed must be increased. There are none of these drawbacks when using the latest types of field-control motors (I do not refer to electrical field control, but magnetic). Mr. Hanchett's formulæ condemn the use of armature-resistance control, as they show that for a lathe of about 18 ins. swing a 6-h.p. motor would be used, while with field control but one horse-power is necessary. Putting 6-h.p. motors on 18-in. lathes would make the cost of the tools rather high, and the article if read by inexperienced purchasers or tool makers might prevent the use of motor drive for tools. I do not wish to start a controversy, but only desire to know what is best and to increase my knowledge. If I am wrong, I will be glad to learn why.

JAMES E. MCHUGH.

Pleasant Ridge, Ohio.

Brush Arc Dynamo Commutators.

I have had several years' experience with the old Brush direct-current arc machine, and I find that there are a great many of these dynamos still in use throughout the country. Most of the difficulty with these troublesome old machines is with the commutators, and there have been more than a dozen "patent" commutators gotten out, almost all of which are worse than useless. I will try to describe a kind of commutator that I have been making and using for two years, not because it is ideal, but because it serves the purpose better than anything else I have been able to find. It is not unlike the original Brush commutator, for the electrical principle is exactly the same, and I use the same kind of segments and wood blocks. The Brush commutator consisted of a wooden hub on which was laid a layer of paper, then the brass segments, and finally the copper segments and wood blocks. The lead-in wires passed from the brass segments down through the paper layer, under which they ran out to the end of the commutator. Some of the objections to this arrangement were that the paper did not furnish a solid support for the segments and wood blocks, and the holes made by the screws soon became worn beyond repair. To make my commutator I take a piece of well-seasoned maple and turn up a hub of sufficient diameter, so that I do not need any paper at all under the segments. On the surface of this I mark out the exact positions in which I want the wires to lay. Then while the work is still between the centers of a small lathe I place a special tool in the rest and cut slots for the wires about 3/8 inch deep by drawing the carriage back and forth by hand. Then the wires are laid in these slots, leaving one end of each sticking up just where it is to be soldered to its segment. This done, I glue in strips of wood to fill up the slots and keep the wires down in the slots. When the glue is dry I boil the whole in paraffine; this helps the insulation and stops all further

shrinking and swelling. Finally, I mount the segments and wood blocks in the usual way, and have a good, solid, true commutator. I connect the commutator to the armature leads by means of small screw-connectors instead of soldering them. Any engineer can make this commutator easily and quickly himself, and it is so cheap that one can always be kept on hand so that when one wears out or becomes damaged it can be pulled off and replaced by this one in a few minutes.

ALBERT G. FULTON.

Oconto, Wis.

Care of Storage Batteries.

Referring to Mr. R. P. Bryan's letter on storage batteries, in the January number of your paper, would say that I charge them to 2.5 or 2.6 volts per cell, with the specific gravity at 1200 degs. to 1205 degs., according to the temperature of the battery room, for as the temperature rises 10 degs. Fahr., the specific gravity will rise 3 degs., and *vice versa* when it lowers. I have found in my experience that the specific gravity is just as important as the voltage, if not more so, as the latter when the battery is fully charged, before disconnecting the charging circuit, may rise to 2.5 volts per cell, and yet the specific gravity may not be up to what it should be; but when the specific gravity rises to 1200 degs. or 1205 degs. the voltage will at all times be normal, except when a short-circuit in the battery comes on. The average specific gravity drops during discharge and the number of points lost should be regained on the charge; the voltage will then be correct if one always takes into consideration the drop and rise in the temperature of the battery room, as stated before.

ERNEST F. HARTWELL.

Hoboken, N. J.

Noticing a question raised by R. P. Bryan in your January issue on storage batteries, I submit the following views on the subject, thinking they may be of some interest to Mr. Bryan in handling his plant. The fall of e.m.f. of a storage battery after the battery has been taken off the charging circuit always occurs. The battery will generally come back to the normal of 2 volts per cell and hold that almost to within 80 per cent. of the charging capacity, providing it is of a good standard make. I should advise Mr. Bryan to accustom himself to the use of an acidometer, generally called hydrometer, to test the density of his electrolyte and not go altogether by the voltmeter. Take, for instance, a battery of cells used for lighting purposes, which has by overdischarging formed a thin coat of sulphate of lead on the plates; after being on the charging circuit for the time required for a practical charge, the battery will come to a boil, or become cloudy, and perhaps the voltage is up a point above 2 volts per cell. It will be found on taking this battery off the charging circuit that its storage capacity is not by any means up to standard. The cause is the sulphate on the face of the active material. The slower charging process for destroying sulphate is recommended, and I have found it successful if properly applied. The condition of a battery may usually be noted by a look at the edges of the plates, both negative and positive, when one has become accustomed to the various changes of color during the process of charging. If the positive plate shows a dark seal brown coating and the paste or active material is easily removed by rubbing a finger tip over it, I will vouch for the plate being in a good condition to take its normal charge. The negative plate should be a clear slate gray color, a shade dark. The acidometer will detect sulphate by not registering as much as before the sulphate formed. My advice is not to discharge a battery further than to cause a fall of over 20 degs. ordinarily, and never over 25 degs., in the specific gravity of the electrolyte. Beyond this point, a number of things happen if discharging is continued, such as sulphating both plates, hardening the grids and making them liable to buckle and break, hardening the active material and causing it to shrink and possibly fall out of the grids, etc.

H. N. SNYDER.

Santa Paula, Cal.

Unequal Heating of Commutator Brushes.

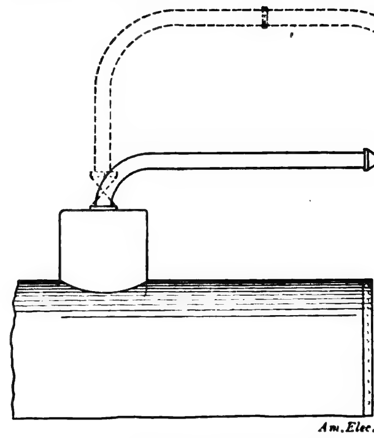
On page 99 of the February issue of the AMERICAN ELECTRICIAN, M. I. H. asks why the negative brushes of a rotary converter become overheated sooner than the positive brushes with an overload. There is a very good reason for it, for while a brush is negative with reference to the circuit, it is positive with reference to the commutator. In other words, the current travels from the negative brush to the commutator and from the commutator to the positive brush. It is a well-known fact that when two electrodes are placed in a direct-current circuit, and especially when the electrodes are of carbon, the positive electrode will heat a great deal more than the negative. This is demonstrated in the arc lamp. While the brush may not be actually flashing yet, on overload the sparking under the face is enough to decidedly overheat the negative brush. At the positive brush, however, the positive electrode is the connector, which is a much better conductor of heat, and having a much greater radiating surface it leaves the positive brushes comparatively cool.

E. C. MEILLORET.

Woodhaven Junction, N. Y.

Mr. Walthall's Boiler Connections.

In the January issue of the AMERICAN ELECTRICIAN, Mr. M. E. Walthall asked for the opinions of others on his boiler connections. According to my notions, both of his ideas are at fault, if the boiler is in a battery and steam is used from the other boilers through this same header. The connection shown in the solid lines does not allow for expansion of the header, which is liable to break the fittings at the valve. The piping should also drain toward the boiler from the valve and the header should drain toward the engine. The arrangement shown in dotted lines allows for expansion and also



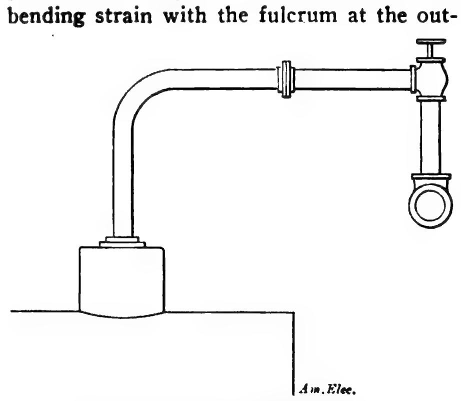
BOILER CONNECTIONS.

allows water to collect over the valve in the pipe. I should prefer the arrangement shown by the accompanying sketch. By placing the angle valve over the header and draining the piping as stated before, it does not allow any water to collect in the connections, and also allows for expansion.

M. C. ST. JOHN.

Rayne, La.

Referring to Mr. Walthall's question on boiler connections in your January issue, to which Mr. Brand and Mr. Trotman replied last month, I cannot agree with the solution offered by either. The piping as shown by the solid lines is clearly wrong in that no provision is made for expansion, and the stress due to this cause will come against the header springing it sideways, and upon the connections at the dome. If the header is properly braced so as to be absolutely rigid in all transverse directions, then the elongation must take place toward the boiler and if the bend is sufficiently stiff might be stressed beyond its elastic limit. I cannot agree with Mr. Brand that the strain at this point is shearing, but consider it rather a bending strain with the fulcrum at the out-



MR. ST. JOHN'S ARRANGEMENT.

side of the curve of the pipe near the dome and the probable point of rupture on the side toward the header.

The connection, as shown by the dotted line, is the more desirable since, owing to the considerable length of the vertical pipes and the flexibility of the bends, it will have sufficient spring to take care of its own ex-

pansion and the effect upon the connections will be harmless.

The introduction of other bends or loops would be needless as far as expansion is concerned, and would only tend to obstruct the flow of steam. There should be a valve at both the boiler and header, and if the boiler is operated within the limits of New York City this will be required. This will eliminate any condensation taking place when the boiler is out of commission.

Long sweep bends in boiler delivery, engine supply pipes, etc., have become standard practice, and are to be found in all the large modern power stations.

LOUIS C. REYNOLDS.

New York.

Referring to the question raised by M. E. Walthall in the January number regarding boiler connections with steam mains, I should say, by all means, that the pipe shown in the dotted lines is the best. If there is anything in steam piping that must be allowed for it is expansion, and if it isn't considered it soon makes itself known. Let anyone bend two pieces of wire, one in the shape of the curved pipe and one the direct pipe, then see how much easier the bent wire will give when the ends are pressed toward each other.

I have charge of a battery of four boilers which were connected to the main in practically the same way as the lower connection in the illustration, and they were always a source of trouble.. Almost every time a boiler was shut down the flanges had to be repacked. One gave so much trouble that we decided to put in a long bend connection very similar to the one shown by the dotted lines, except that a gate valve was inserted near the flanged joint in the highest part of the pipe. That prevented any water from collecting in the pipe.

Since putting in this new pipe we have had no trouble with it whatever, and we will probably equip the other boilers in the same way.

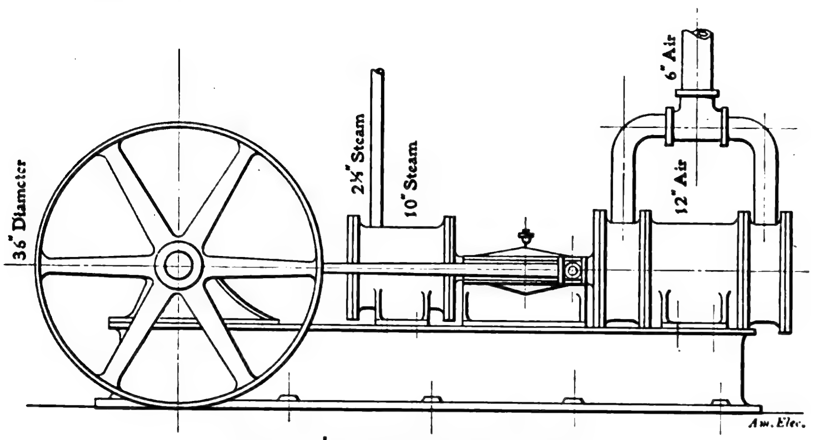
The stress due to pipe expansion was so great on this particular boiler that it strained the nozzle on the boiler, and came very near fracturing the ell in the piping.

If it is thought advisable to have two valves one should be put at either end and suitable drains placed in the piping to let out the water which collects in them. In starting a fire in an idle boiler under such conditions one valve should be opened, and when ready to connect with other boilers the water above the valve should be drawn off, otherwise disastrous water hammer is likely to occur.

E. T. REID.

North Abington, Mass.

Doubling the Capacity of a Vacuum Pump.

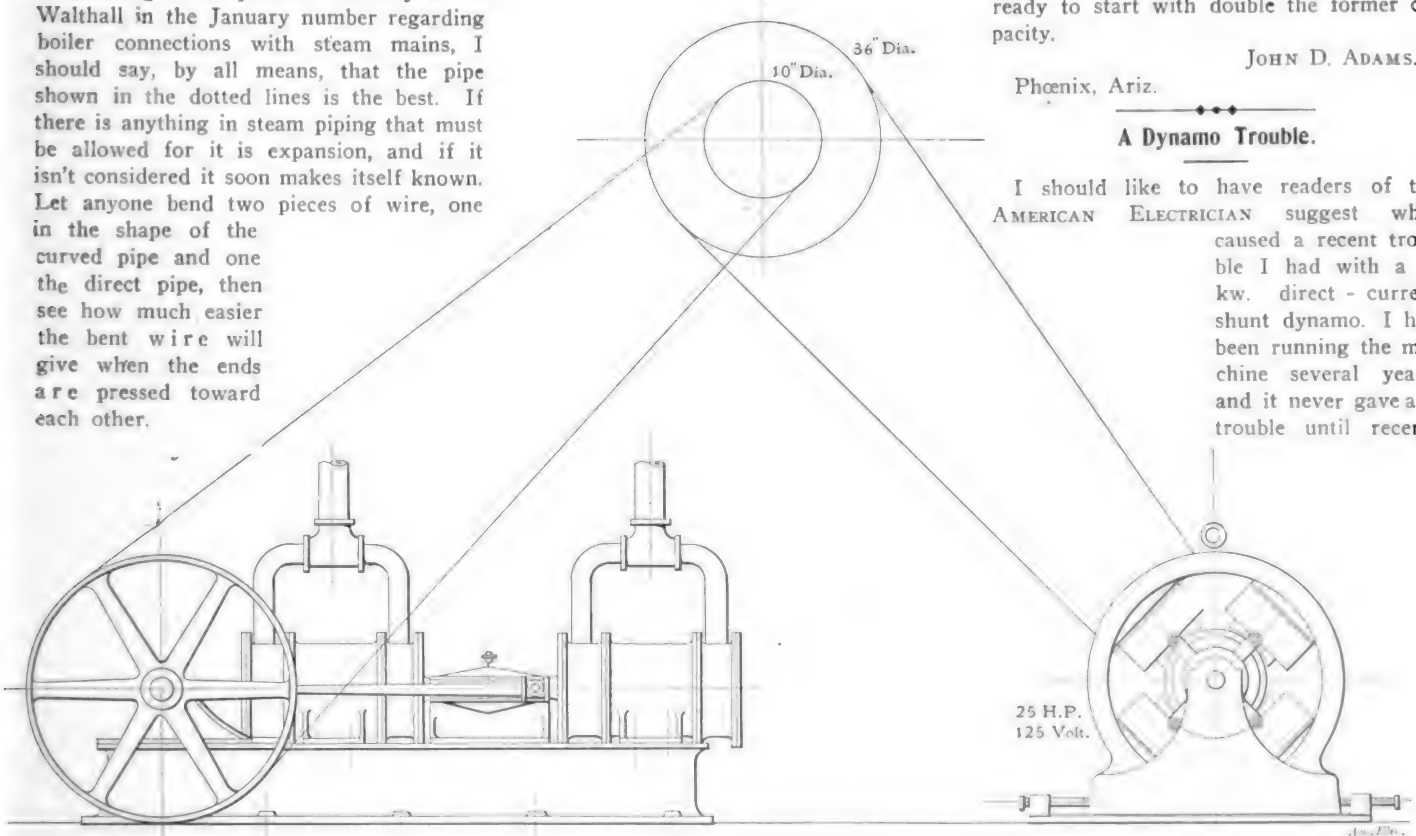


MR. ADAMS' ORIGINAL VACUUM PUMP.

We had a 10 in. by 12 in. by 12 in. stroke, straight line steam-driven, vacuum pump maintaining a vacuum of 15 in. according to the mercury gauge. It was necessary to have a pump of greater capacity, and as we had a couple of small pressure pumps for the sprinkler system alarm in the same room, we decided to replace the steam drive with its 100 ft. of piping, by a belt driven machine, and use a motor to operate the three pumps. Instead of buying a new pump, we had our own machine shop turn out a duplicate of the present air cylinder with which to replace the steam cylinder and drive both by a belt on the flywheel. The new arrangement will be evident by referring to the sketch herewith, and proved very desirable in every way. The change as made in our own shop was much cheaper than a new machine, and as for the electric drive it gave less trouble than the 100-ft. steam line, and also enabled us to handle the small pressure pumps advantageously. Everything was in readiness, so that when the pump was shut down Saturday noon, the work of making the change was commenced and by Monday morning everything was ready to start with double the former capacity.

JOHN D. ADAMS.

Phœnix, Ariz.



MR. ADAMS' VACUUM PUMP, HAVING DOUBLE THE CAPACITY OF THE ORIGINAL.

A Dynamo Trouble.

I should like to have readers of the AMERICAN ELECTRICIAN suggest what caused a recent trouble I had with a 2-kw. direct-current shunt dynamo. I had been running the machine several years, and it never gave any trouble until recently, when two leads became short-circuited in the armature. The armature was taken out and the trouble repaired, which only consisted of a single wire being burned close to where it is soldered to the commutator.

The armature was replaced and the machine started up, but it would not pick up. We tried every way possible to make it do so with the same condition under which it had run before, but without success. We finally discovered that the residual magnetism tended to excite the fields in the wrong direction. We, of course, reversed

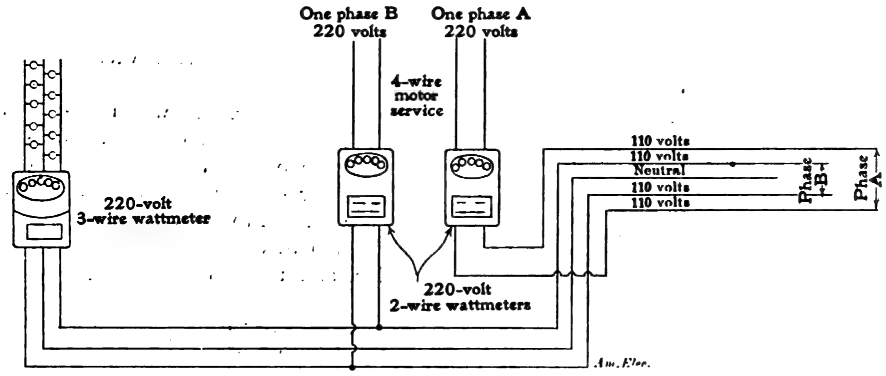


FIG. 1.—DIAGRAM OF SERVICE WIRES SUPPLYING CURRENT FOR LIGHT AND POWER.

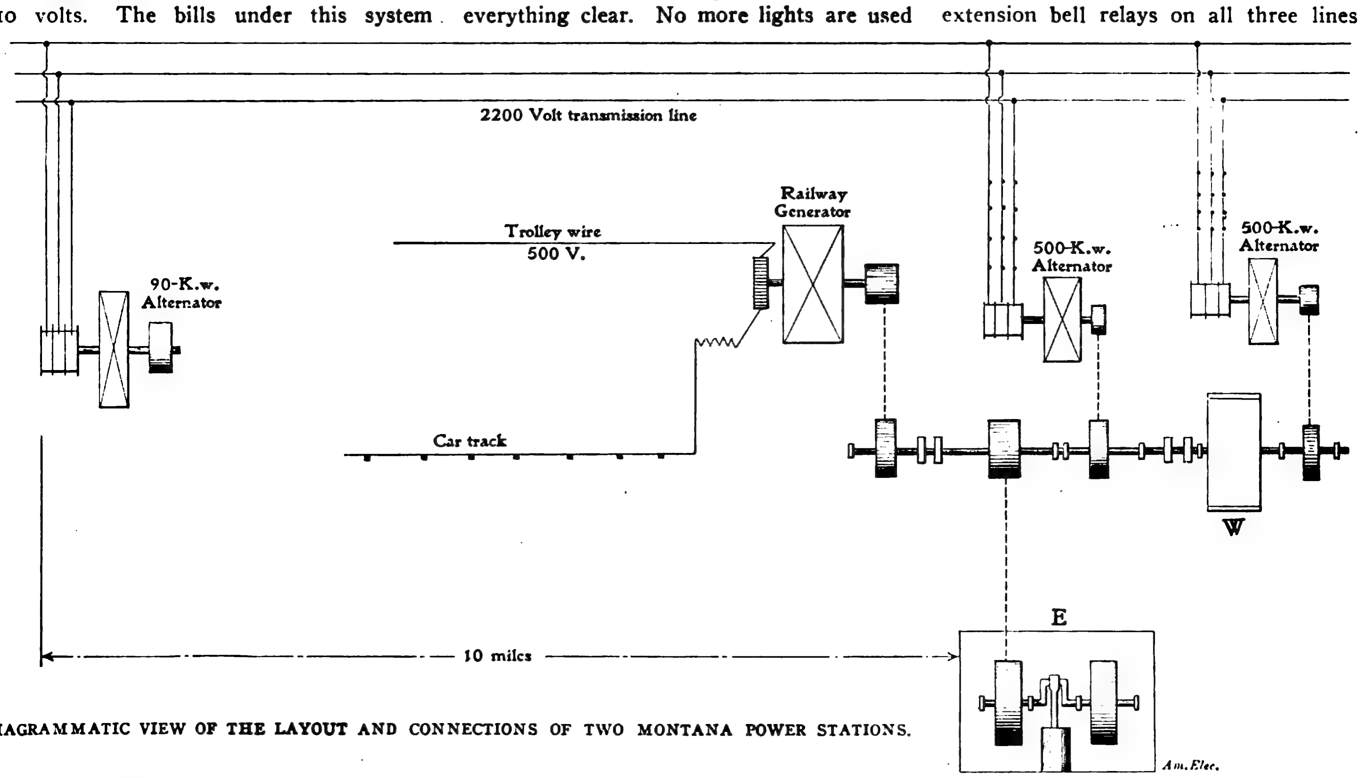
the field leads and the machine immediately picked up. Now, why was it necessary to reverse the fields after the machine had been running for years without trouble? The armature connections were not changed, neither was the position of the brushes altered.

J. T. Bannister.

Richmond, Va.

Excessive Current Consumption.

I would like to know what would cause an increase in the bills for electricity consumed in the following case: The lighting system installed eight years ago was a two-wire, single-phase, alternating current of 110 volts. The bills under this system



DIAGRAMMATIC VIEW OF THE LAYOUT AND CONNECTIONS OF TWO MONTANA POWER STATIONS.

ranged from $35 to $40 per month, using 16-c.p. lamps. About ten months ago the lamps were changed to 8-c.p., 3½-watt lamps, and the bills amounted to $15 and $17, which was exactly what was looked for by the consumer. This continued for about six months, when the consumer decided to have a 2-h.p. motor installed. The company furnishing the current decided to have this motor two-phase, four-wire, 220 volts, and in running in the service wires for this motor they used five wires, and decided to change the old lighting system from a two to a three-wire system. On the day this change was made the reading was taken for the light consumed during the month and the bill amounted to about $15. The month following this change of wiring the bill amounted to $32, and since then is anywhere from $32 to $40. The motor being on a separate meter, for which a separate bill is rendered, the above amounts are for light only. The consumer naturally made strenuous objections to this increase, and the company claims to have made every known test, and not finding anything wrong, are still claiming payment at the increased rate. The bills, however, remain unpaid. I am at a loss to account for the increase. I have made tests for grounds, and find everything clear. No more lights are used than before, and these are not used any longer than when the bills ranged from $15 to $17. I would like very much to get a solution of this problem through your valuable paper. Fig. 1 is a diagram of the service wires which supply the motor and lights.

J. C. Vogel.

Philadelphia, Pa.

A Question in Station Operation.

The enclosed diagram shows roughly the layout and connections of our two power stations. At the main station there are two 500-kw. alternators, driven normally by the water-wheel, *W*, the engine, *E*, being used only in emergencies. The pulleys on the line-shaft of the water-whel are provided with clutches. The alternator in the distant station is a 90-kw. machine, but it is impossible to make it take more than 20 to 22 amperes without dragging on the machines at the main station. Also, when a heavy load comes on the railway generator at the main station, it throws an extra load on the distant alternator. The exciter of this latter machine is speeded at only 1900 r.p.m., although the speed on the name-plate is 2200. I will appreciate it if readers of this paper will express their opinions as to the causes and remedies of the troubles mentioned.

L. R. Clarke.

Bozeman, Mont.

Problem in Telephone Connections.

I would like to submit a small problem to readers of this paper. We have three telephone lines centering at one place, with a single telephone set which may be connected to any one of the three lines, and extension bell relays on all three lines to receive calls. The lines are all metallic circuit, the instrument the ordinary bridging type. It is desired to arrange standard knife-bade switches so that when any two of the lines are connected together the third

may be independently called or answered.

Laurence P. Brode.

Colton, Cal.

Information Desired.

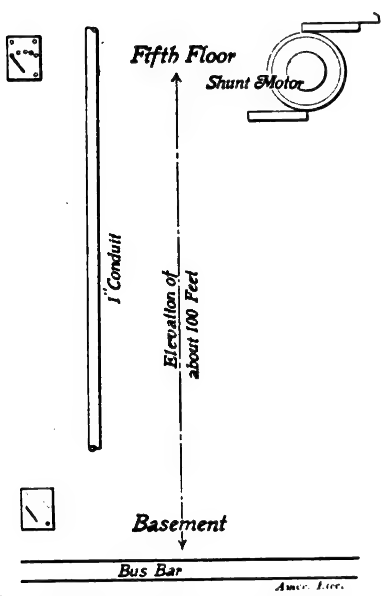
Can any of the American Electrician readers instruct me as to the proper winding for the S. K. C. ½-h.p. alternating-current motor for 100 volts and 66 cycles? The machine has four poles, and the armature 56 slots.

L. G. Esther.

Halifax, N. S.

Problem in Motor Connections.

I have a motor problem which is rather puzzling, and I think it will be of interest to your readers. A 7½-h.p. direct-current motor is to run on a 220-volt circuit. One starting box is in the basement on the



PROBLEM IN MOTOR CONNECTIONS.

switchboard; the other is on the fifth floor with the motor. The motor is to be started from either place or stopped from either place. The wires that go to the starting box and motor are to be run through a 1-in. conduit. The total length of conduit is about 200 ft., but the elevation to the motor is 100 ft. It does not make any difference what kind of apparatus is used, so long as the work will pass inspection. The machine is a shunt-wound motor. It might be well to say that three No. 6 or four No. 8 wires can be run through the pipe. The accompanying sketch shows the apparatus located in the proper places.

Harold M. Wolf.

Cleveland, Ohio.

Sleet on Electric Line Wires.

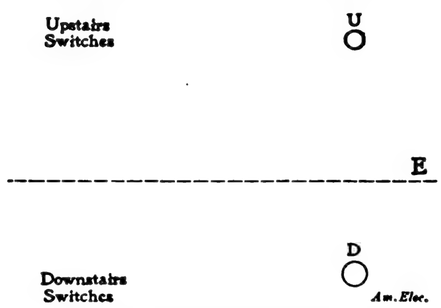
The statement is often made that sleet does not form on bare, high-tension wires, and in that connection I would like to say that as this letter is being written (February 8) it is sleeting, and our 12,000-volt, three-phase transmission line is covered with ice ½ inch thick—with current on the wires. I should like to ask through this department of the American Electrician, whether any of its readers ever saw sleet, snow or ice on a 50,000 or 60,000-volt transmission line?

F. P. Catchings.

Gainesville, Ga.

Problem in Switch Connections.

Perhaps the accompanying diagram will afford some mental exercise to readers of the American Electrician. The diagram represents an incandescent lamp, *U*, in the upper hall of a residence, another lamp, *D*, in the lower hall and the main entrance for the wiring, *E*. The problem is to connect



PROBLEM IN SWITCH CONNECTIONS.

the two lamps with switches located in the two halls in such manner that the lamps can be put in circuit in parallel from either one of the switch stations, or put in series at the upstairs switch station; also, either lamp can be extinguished from either switch, leaving the other lamp burning. Only standard switches and the least practical quantity of materials must be used. Summing up, the following results must be obtainable:

At either switch station, either one or both lamps may be lighted at full candle-power and extinguished, regardless of the condition of the switches at the other station, except that when in series, they can only be extinguished and lighted from downstairs—not controlled separately.

At the upstairs station, in addition, the lamps may be connected in series for night service, regardless of the positions of the switches downstairs.

B. F. M. Weaver.

Wilmington, Del.

Mr. Westervelt's Insulation Resistance.

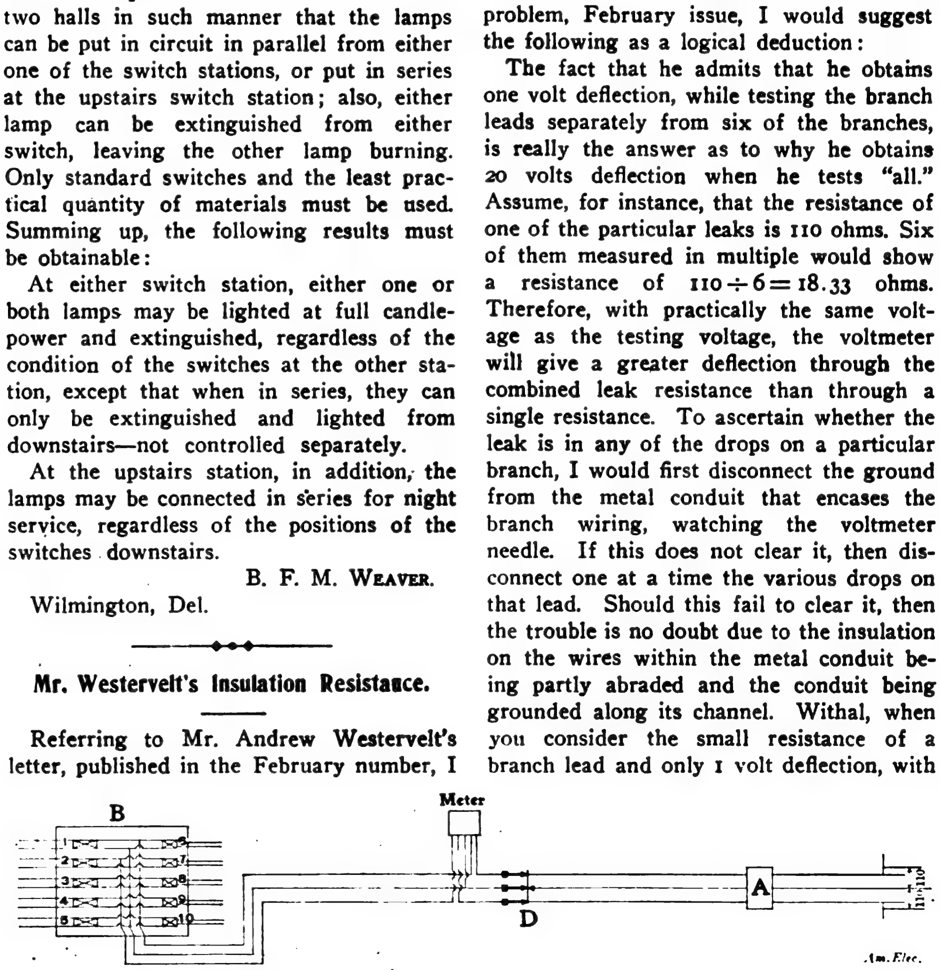
Referring to Mr. Andrew Westervelt's letter, published in the February number, I should think his trouble due either to dampness in the fittings and switches, or possibly in the wire. I would say it was what I have frequently found, grounds due to dampness in the fittings which were mounted on the metal outlets of the conduit, but as he says that in each of the six circuits he only had one volt to each, and yet 20 volts in the total branches, it puts the trouble in a different light. Finding the resistance of each of the six circuits by the formula,

$$R = r\left(\frac{E}{v} - 1\right),$$

in which r is the resistance of the voltmeter; E the line voltage, and v the voltage to ground indicated by the meter, and then finding the joint resistance of the six circuits, would not give a total of 20 volts leack. I think it possible that when Mr. Westervelt took the reading of the separate branches he obtained a ground reading of one volt, but in taking the reading of the fuse block he got a reading showing that there was a shunt path for the outside line voltage of 220 volts, which excluded the ground. I do not think he had the meters connected as shown, for he would have had a high reading on the side on which the meter armature was shunted.

W. A. Loveland.

Philadelphia, Pa.



MR. WESTERVELT'S INSULATION RESISTANCE PROBLEM.

Referring to Mr. Westervelt's insulation problem, February issue, I would suggest the following as a logical deduction:

The fact that he admits that he obtains one volt deflection, while testing the branch leads separately from six of the branches, is really the answer as to why he obtains 20 volts deflection when he tests "all." Assume, for instance, that the resistance of one of the particular leaks is 110 ohms. Six of them measured in multiple would show a resistance of $110 \div 6 = 18.33$ ohms. Therefore, with practically the same voltage as the testing voltage, the voltmeter will give a greater deflection through the combined leak resistance than through a single resistance. To ascertain whether the leak is in any of the drops on a particular branch, I would first disconnect the ground from the metal conduit that encases the branch wiring, watching the voltmeter needle. If this does not clear it, then disconnect one at a time the various drops on that lead. Should this fail to clear it, then the trouble is no doubt due to the insulation on the wires within the metal conduit being partly abraded and the conduit being grounded along its channel. Withal, when you consider the small resistance of a branch lead and only 1 volt deflection, with 110 volts, I doubt very seriously the necessity for giving the wiring much concern.

James B. Dillon.

Louisville, Ky.

Questions and Answers

Inquiries not accompanied by the name and address of the inquirer, will not receive attention.

Would it be advisable to use a three-phase induction motor for operating an elevator of 6000 lbs. capacity, the motor to be supplied from a 230-volt monocyclic circuit? The motor would be a 25-h.p. machine. B. A. S.

No; either get a monocyclic motor or change your supply to symmetrical polyphase.

A home-made arc lamp, operated on a 100-volt, alternating-current circuit in series with resistance coils, works all right, but a short time after starting up it begins to hum. What is probably the cause? R. L. C.

Some of the mechanism loosens up from expansion due to the warmth of the lamp; any loose joints, screws, etc., in an alternating-current lamp mechanism will hum.

In thawing out frozen water pipes by electricity, does not the current spread into the surrounding earth between the ends of the pipe, and if so, how is the middle part of the pipe thawed out? A. E. G.

Some current may pass through the adjacent earth, but that does not prevent most of it from passing through the iron pipe, which is of much lower resistance.

How can a single-phase, four-pole induction motor be changed from 100 volts and 125 cycles to 200 volts and 50 cycles without changing its horse-power? D. L. F.

It can't be done, but if the motor be rewound for two poles with twice the original total number of turns in the stator winding, it will work moderately well at almost the original power.

What is the best way to utilize 2080-volt transformers on a 2300-volt circuit? (2) Can I use transformers wound for 2080-volt primary e.m.f. and 230-volts secondary on a 2300-volt primary circuit and get 220 volts at the secondary terminals? W. J. N.

Use them as though they were intended for 2300 volts. The secondary e.m.f., however, will be somewhat higher than the rated e.m.f. (2) No; the secondary e.m.f. will be 254 volts.

What is the best insulator to use on a 2200-volt line in a damp climate? (2) Is there any compound with which the wire could be coated at the points where the wire is attached to the insulators for decreasing the leakage in wet weather? (3) What is a cycle? G. H. B.

A glass or porcelain insulator of the multi-petticoat type, made for the conditions mentioned. (2) No; the entire wire is coated with a good compound by the manufacturer, if it is a standard brand. (3) We have defined the word many times in the past year or two. See pages 411 and 424, August, 1904.

Is it good practice to use rubber-covered, lead-sheathed conductors for underground work? (2) In running a number of underground circuits parallel with each other, would it be better to put all the positive conductors in one conduit and the negatives in another, or to put in each conduit both conductors of each circuit contained therein? J. M. D.

Yes; but it is rather expensive. (2) If there is no possibility of ever using alternating current, one method is as good as the other electrically; but where alternating current is used or may be used in future, all the conductors of any one circuit must go in the same tube.

What is the best way to equip a house 50 x 65 feet with lightning rods? (2) What material should be used in the rods? (3) Should they be insulated from the house? F. E. B.

The best way to attempt protection from lightning is to erect four or five poles about 25 feet from the house, equidistant from each other, and so located that a line drawn from pole to pole successively will encircle the house. Put an individual rod on each pole. The rod tips should be considerably higher than the house—say 15 to 20 feet above its highest point. If, however, you put the rods on the house, put one at the apex of each gable, or, if a mansard roof, one at each corner. Use individual grounds for the rods. (2) Copper. (3) Preferably.

What is the best method of testing out the plan of armature-to-commutator connections of a direct-current dynamo or motor? B. C. H.

Disconnect one lead from one coil; connect one terminal of a voltmeter to the disconnected lead and the other terminal to a circuit of appropriate voltage; disconnect two other coil leads, each about one-third of the commutator circumference away from the first one, and leave them free; with a lead from the other side of the supply circuit, test the commutator bars until one is reached which causes the voltmeter to give an indication equal to the voltage of the circuit. This last commutator bar will be connected to the other lead of the coil which is connected to one post of the voltmeter, and the distance apart of the two bars to which this coil is connected will be the basis of the winding plan.

What is the correct arrangement of leads and instruments in connecting a compound-wound direct-current dynamo to the bus-bars? (2) What simple solution can be used for oxidizing copper-plated metal? A. W. R.

The lead from the free terminal of the series winding should go directly to one pole of the main switch; the lead from the junction of the series winding and brush connection goes to the equalizer switch; the remaining lead, from the free brush terminal, should go first to the circuit-breaker, then to the individual ammeter and finally to the main switch. It is usually more convenient mechanically to carry the last-mentioned circuit from the circuit-breaker to the main switch, and put the ammeter between the switch and the bus-bars; it is of small importance which sequence is observed, but logically the main switch should be last in the chain from the machine to the bus-bars. (2) Dip the object to be oxidized in the following solution: Liver of sulphur, 3 ozs.; ammonia, 1 oz.; water, 1 gallon.

What potential will be required to run a series-wound dynamo as a motor at full speed, the dynamo being capable of supplying 20 lamps of 50 volts each? (2) Why does not a vacuum show gauge readings corresponding with the readings of a steam gauge under similar conditions? G. P.

About 1000 volts, that being the e.m.f. of the machine when used as a dynamo. (2) Because a vacuum is absence of pressure. A vacuum gauge will vary oppositely to the variations of a steam gauge pointer under similarly varying conditions; thus, a rise in steam pressure will cause the gauge to give a higher reading, but an increase in the pressure within a vacuum chamber will lower the reading of the vacuum gauge, which registers the difference between the internal pressure and the atmospheric pressure. If a pressure gauge and a vacuum gauge be connected side by side to a vacuum chamber, any variation in the degree of vacuum will cause the two pointers to move in opposite directions.

In this department of the January number you gave to J. W. W. data for rewinding a compound-wound dynamo for a higher voltage; will the machine run at the original speed after being rewound? (2) What is the formula for rewinding machines for different voltages at the same speed? (3) What is the formula for rewinding for a different voltage and different speed? J. J. H.

Practically the same speed. (2) Divide the voltage for which the machine was built by the voltage to which it is to be changed; multiply the result by the cross-sectional area of the wire now on the machine, and the final result will be the cross-sectional area of the wire to be used in rewinding. This applies to both the armature and field windings of the machine. The shunt field winding should occupy the same cubic space as before. To ascertain the number of turns for the new series field winding, or the new total number of turns on the armature divide the original voltage by the original number of turns and multiply the result by the proposed voltage. The proper division of the total armature turns into individual coils is a matter of dynamo design and cannot be covered by a mere formula. (3) There is none; no such radical changes can be made successfully without knowledge of dynamo design.

Can a dead short-circuit across two commutator bars of a dynamo or motor be located without removing any of the armature leads from the commutator lugs? (2) What is meant by the rating of an induction regulator at so many kilowatts? (3) What is the difference between a current transformer and a potential transformer? E. M.

Yes; secure the armature so it cannot turn, pass full-load current through it by means of connections from the brushes to a supply source in series with a regulating resistance, such as a water rheostat, and test the difference of potential between each pair of adjacent commutator bars all the way around. If at any pair of bars there is no deflection whatever of the voltmeter needle, those two bars are short-circuited together, either in the commutator itself or in the armature coil connected to them. The voltmeter must be very low-reading, the full scale being not more than 10 volts. (2) That the maximum counter e.m.f. of the regulator, multiplied by its maximum current capacity equals its rating in *watts*. (3) It is purely structural; the current transformer has a very low-resistance primary winding—frequently a single turn of conductor—and the potential transformer has a high-resistance winding. The former is connected in series with the work circuit while the latter is connected in parallel with the circuit.

A MODERN HOT AIR ENGINE.

BY G. EMIL HESSE.

In these days of industrial activity it is only natural that the external combustion engine, as represented by the Ericsson type, should receive the attention which the hot air engine deserves, especially as the internal combustion engine, which belongs to the same class, has met with such pronounced success both from a technical and a commercial standpoint.

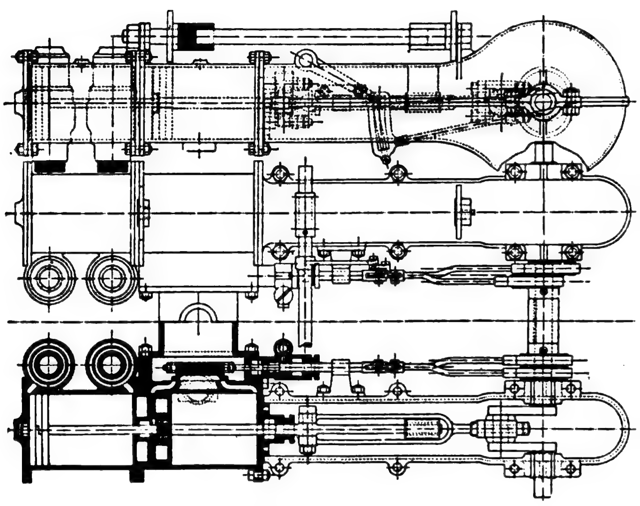


FIG. 1.—6-H.P. SVEA CALORIC ENGINE.

So many inherent, natural difficulties had to be overcome when the gas engine was first taken hold of, and so many still remain, in spite of the time and skill bestowed upon it, that it is a pleasure to record the perseverance of the pioneers in this industry. A rapid way of heating the air had been discovered, however, and the builders knew that they were building on the right foundation.

It was for this reason that the external combustion engine was neglected.. The means employed by Ericsson to heat the air by simply allowing the warmer air, nearest to the heated plates, to rise into the cooler layers above, is too slow to allow its adoption for even a few horse-power.

This was thoroughly demonstrated by Ericsson himself, who built several large hot air engines and the impracticability of heating large volumes of air in the manner employed was well recognized by the creative element in the engineering profession, who severely left it alone for the better method, offered by the internal combustion engine.

If boiling oil is poured on top of cool water it will be found that the heat is only slowly communicated to the layers below, but heat the water from below and it is done rapidly.

Air heated by the ascent of the warm layers into the stationary above is slow, but allow a cool and well divided up body of air to pass over the heated plates at a velocity, which is under absolute control, and the result will be satisfactory. It is well known that the hot gases generated in the furnace on their way through the tubes of a boiler give off the heat to the water. It is this system reversed which is employed in the Svea caloric engine.

The cool air sweeps over the heated plates in a finely divided state at a certain velocity the whole body of air moving and none stationary as in the Ericsson engine, absorbing on its way the heat emitted from the plates. In the large stationary or marine type the air is used under pressure, as in the Rider and Lehmann type, and is used over and over again, but the system of heating it is the same. This, it is claimed, will make the Svea type practical for the largest power without prohibitive size or weight.

The Svea Caloric Engine Co. is now building a six-horse-power engine, applicable for launches, automobiles, etc., and has under way a 100-h.p. stationary engine. The cylinder of the 6-h.p. engine is 4¼ inches in diameter, with a stroke of 4⅞ inches making 450 revolutions per minute. It is self-starting, double-acting, reversible, and, it is claimed, easily controlled, which makes it suitable for all classes of work. The heater is 20 inches in diameter, 16 inches long, and has a heating surface of 60 sq. ft. The total weight of engine and heater complete is 450 pounds, as compared to 1700 pounds for a ½-h.p. Ericsson engine.

The saving of coal accomplished by the hot air engine lies in the fact that it utilizes a medium, which is already in a vapor and consequently does not require the large amount of heat, which water does, before it is vaporized. This is considerable, and is an absolute loss no matter whether it goes into the atmosphere or the condenser.

One kilogram of water at 100 degs. C. requires an expenditure of 537 thermal units, before it is converted into saturated steam of the same temperature. The saving accomplished by the condensation is:

$$\frac{10{,}334 \times 1{,}649}{424\left(\frac{10}{9}-1\right)}\left[1-\left(\frac{1649}{14.55}\right)\right]^{\frac{1}{9}} = 76 \text{ units},$$

making a total net loss of $537 - 76 = 461$ units.

This explains why there should be a great future for the hot air engine. No economy is claimed for the Ericsson engine, which in fact is a fuel eater. The reason for this is that most of the heat goes through the chimney and also on account of the large heat-radiating surface per horse-power exposed to the air. The exposed surfaces of both heater and cylinders of the Svea engine are not larger than those of the steam engine plant. It is besides possible to utilize the heat generated in the furnace in the same economical manner as in a boiler, thereby putting it on an equal footing with the steam engine. No cooling water is needed for the cylinder, which is a great saving, a fact well known to the gas engine designer.

WESTINGHOUSE SINGLE-PHASE RAILWAY SYSTEM.

The successful introduction of an alternating-current railway system removes many of the limitations which have been felt under former conditions, and opens the way for an immense development of electric traction. The new system retains

FIG. 1.—CENTENARY LINE CONSTRUCTION.

some of the best characteristics of the direct-current system; namely, a single working conductor, and the speed-torque characteristics of the series motor, while eliminating many of the weak points inherent in that system.

FIG. 2.—BOW TROLLEY.

The great superiority of the alternating current for the generation and transmission of power has long been recognized, and means have been found, through the rotary converter, to partially utilize alternat-

ing current for railway operation. This is accomplished at the expense of increased complication, and the comparatively low trolley voltage and rheostatic losses still remain.

The Westinghouse single-phase railway system, it is claimed, possesses the successful features of the direct-current system, with efficiency and elasticity of service greatly increased. Expensive rotary converter sub-stations are replaced by small transformer houses containing apparatus, which requires only occasional attention.

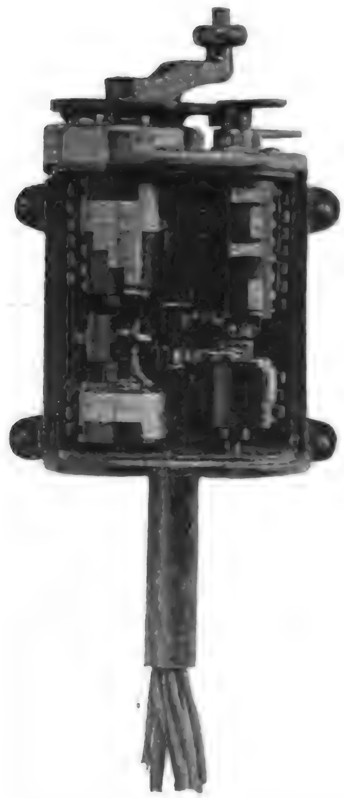


FIG. 3.—MASTER CONTROLLER FOR MULTIPLE CONTROL.

Line losses are decreased, and rheostatic losses practically abolished. The power is supplied to the car at a high voltage, so that the difficulties of collecting heavy currents are eliminated. The method of voltage control enables emergency conditions to be economically met. As transformers are interposed between all apparatus and the line, the problem of protecting single-phase motors from lightning becomes very simple.

A frequency of 25 cycles is standard for the Westinghouse single-phase system. This frequency is now used in most existing railway and power installations, so that the new system is perfectly adapted to present systems of generation and transmission.

The single-phase system involves no complications in the generating stations or transmission line. Standard polyphase generators with a frequency of 25 cycles are used. The generation and high tension transmission may be single-phase, two-phase or three-phase, according to local conditions but the ease of changing from two to three-phase, or *vice versa*, by transformer connections makes it possible to adapt the whole or a part of any existing system to single-phase railway work.

The high voltage of the transmission is stepped down through transformers to the voltage used on the trolley. The transformers used for this purpose are placed at the proper points along the line, usually in small transformer houses. In these houses is also placed the proper overload and lightning protection; there is no moving machinery, and only occasional inspection is required. The contrast between such a station and the rotary sub-station is very marked, and the absence of attendants is an item of no small importance, while the decreased complication is certain to result in improved continuity of service. In some cases the transformers are mounted on trucks and the spare transformers kept at central points along the line, so that when it is necessary to repair a transformer at any station it may be replaced by another taken from one of the central points. This practice reduces the number of space transformers required, as well as the number of repair men. In other cases, where the traffic is temporarily increased on some section of the line, as by some great gathering of people on certain days or certain seasons of the year, spare transformers may be placed on a car, and a temporary transformer station readily installed, to reduce the loss in the trolley. Such an arrangement materially cuts down the cost of transformer equipment. The distance between transformer stations depends on the trolley voltage used, the density of the traffic, etc.

The standard trolley voltages are 2200 and 3300 volts, though in cases where it is required, a lower voltage may be used within city limits. For changing the connections on the car in passing from one voltage to another, a simple change-over switch is all that is necessary. In many cases of suburban and interurban service all trolley feeders may be dispensed with, the trolley itself being sufficient to carry the necessary current. Union standard or bow trolleys are used according to trolley voltage and speed of cars.

An auto-transformer installed on each car supplies the motors, reducing the voltage of the trolley to 250 volts, which is

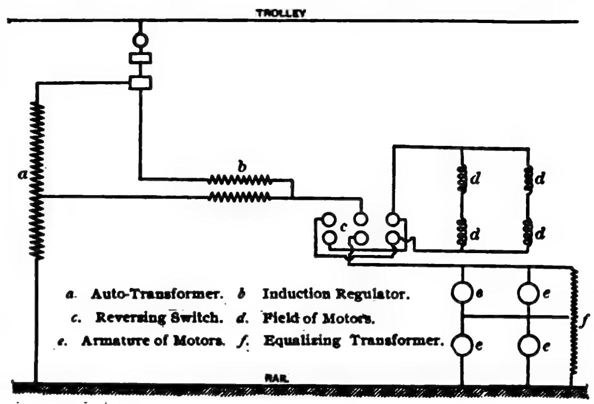


FIG. 5.—DIAGRAM OF CONNECTIONS

standard for the motors. The lamps, heating apparatus, and the small motor which drives the air-pump for braking, etc., are also supplied from an auto-transformer.

The induction regulator is virtually an auto-transformer with movable secondary, which is used to vary the voltage at the motor terminals. The variation is produced entirely by induction, without breaking any circuit in passing from one voltage to another. The regulator is connected in series with the circuit, and its variable voltage is added to or subtracted from that of the main transformer.

The regulator, as well as the reverse switch and circuit-breaker is operated by compressed air from the motor-driven system. The control is through a small controller, which operates electromagnetic valves by means of current from a storage battery. This system of control is said to be admirably adapted to multiple unit operation, and an equipment may be operated continuously, it is said, on the lowest speeds, maintaining good efficiency and a smooth motion. This feature is important in city work when, to obtain the low

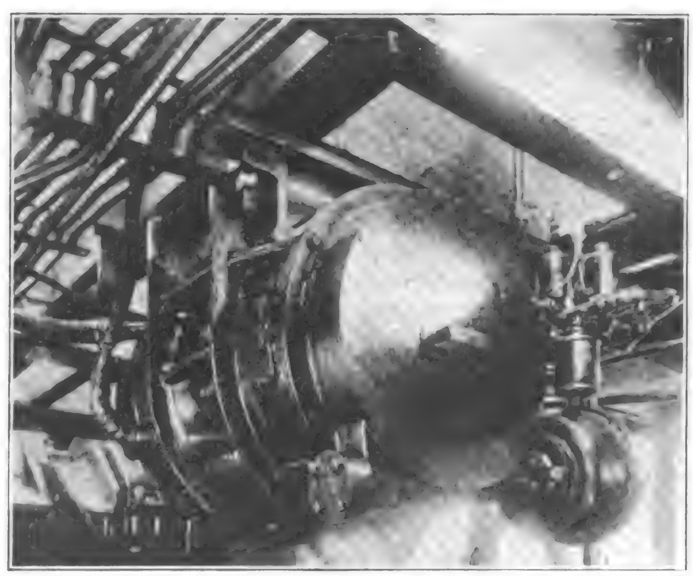


FIG. 4.—MASTER CONTROLLER UNDER CAR.

speeds required, a direct-current equipment must be moved by a series of jerks, since the resistance is not designed for continuous operation at low speeds.

With the alternating-current system of voltage control every point is a running point. The two coils of the regulator are shown diagrammatically in Fig. 5. They are wound on separate cores, and so mounted that their relative angular position may be varied at will. The primary coil, *b*, is connected between the trolley and the motors. One end of the secondary coil is connected to the auto-transformer, *a;* the other joins the primary at the motors. This arrangement provides a voltage range double that of the regulator, and consequently permits the use of a smaller size than would otherwise be possible.

The air for operating brakes and other apparatus is held in reservoirs in which the pressure is maintained constant by a small single-phase motor in a manner similar to that used in large direct-current equipments.

The Westinghouse single-phase railway motor is made in standard sizes of 50, 75, 100 and 150 horse-power, nominal rating, and the line includes motors suitable for practically every class of service. The normal rated voltage of these motors is 250 volts. This low motor voltage, combined with a high trolley voltage, the manufacturer claims, is the ideal condition, and is made possible by the use of transformers, as previously explained.

In general appearance the single-phase railway motor differs little from the standard direct-current forms. It is of the box type, the outer frame being of cast steel, and supporting the annular laminations of the field. The end brackets are accurately fitted on machined seats and carry the armature bearings, which are of the most modern type. The brush-holders are also bolted to the end brackets. The armature closely resembles that of standard direct-current motors in general appearance. It is of the drum type, and is provided with generous ventilating spaces between the laminations. The bearings and shaft are of ample dimensions, and the entire mechanical design embodies the results of a wide experience in the manufacture of railway motors.

FIG. 6.—100-H.P. SINGLE-PHASE RAILWAY MOTOR.

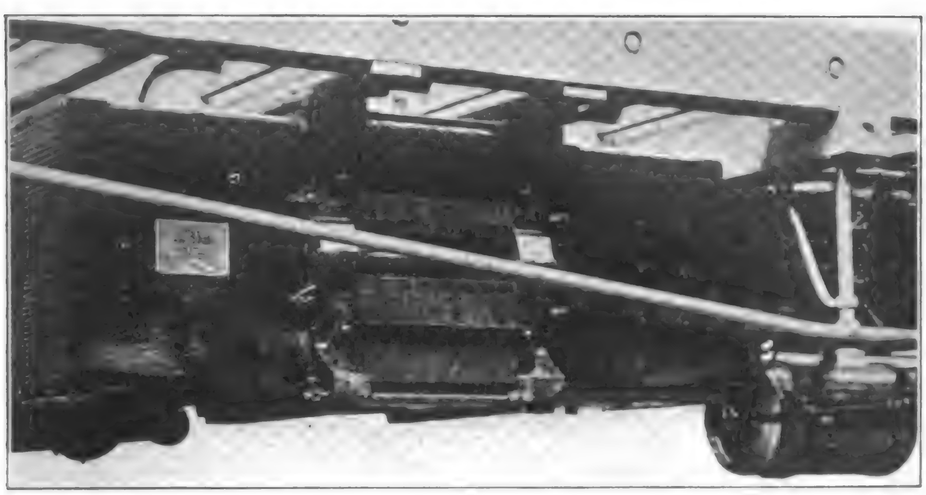


FIG. 7.—AUTO-TRANSFORMER UNDER CAR.

Every motor is subjected to a rigid test and careful inspection of every part while in process of construction. This is supplemented by a final run under load, after which the insulation is given a high-potential break-down test.

Although the system just described is in its primary form a straight alternating-current system, when provided with the proper controlling devices, the motors may be used on direct-current circuits, so that suburban roads may, when it is necessary, run cars into or through towns or cities, using the direct-current trolleys already installed. Where such an arrangement is used, the motors are generally connected in series, and their speed controlled by the ordinary rheostatic system. The adaptation of single-phase motors to direct-current circuits enables the change from a direct to an alternating-current system to be made gradually—operating extensions to the system by alternating current, replacing old direct-current motors as fast as necessary by single-phase motors, and finally changing the whole system, removing all rotary converters, trolley feeders, etc. The accompanying engravings are of a road now in operation.

"TYPE N" LOMBARD GOVERNOR.

The Lombard Governor Company, Boston, Mass., has placed on the market an entirely new type of hydraulic governor which is especially adapted for the requirements of large stations. This new governor is made in two styles, both of which are vertical; Fig. 1 illustrates the vertical type. One large casting forms both the main cylinder and the bearings for the terminal shaft. The base forms the lower cylinder head, and the upper cylinder head is integral with the cylinder; this form of construction being used to obtain maximum strength with the least weight of metal, and to obviate the possibility of joints loosening under the great stresses involved. The straight cylinder construction with piston motion along the axis is retained for the economy of metal and symmetrical distribution of stresses which have been found by experience to be thereby obtainable. The linear motion of the piston is transformed by racks and pinions to rotary motion at the terminal shaft. In order to reduce the vertical height of the governor and also to transmit the force at the piston to the rotating shaft efficiently, double racks and pinions are used, the racks being connected to an equalizing yoke, and the racks are located alongside the cylinder instead of beyond it as has been the custom heretofore.

The steel terminal shaft is 2 15-16 in. in diameter, and it is supported by bearings both sides of the pinions; the total length of bearing of this shaft is 26 inches. The releasing clutch mechanism is of the well-known Lombard design, properly proportioned for the power of the machine. All keyways are extra wide, and the terminal shaft pinions are not only keyed, but also shrunk on at a high temperature. The main piston-rod gland cap is cup-shaped so as to prevent leakage over the machine. The usual form of hand-wheel is employed; this is out of gear when the governor is in regular operation. The working fluid for this governor is a special oil kept under pressure in a vertical draw steel tank. Oil is forced into this tank by a powerful pump which is part of the equipment of the governor.

The special novel feature of the "Type N" governor is the relaying valve mechanism. In the earlier types of Lombard governors, an ingenious mechanical relaying device was used to multiply the comparatively small force and movement of the centrifugal balls sufficiently to control accurately the main valve of the hydraulic cylinder. This mechanism consisted of a combination of an auxiliary valve a small hydraulic cylinder with two outside racks, and a floating gear. As the size of governors increased, this style relaying mechanism proved rather cumbersome, occupying too much valuable space and complicating the remainder of the machine to an undesirable extent. Therefore, there was invented a hydraulic equivalent for all this outside mechanism which has made it possible to build governors of any size and proportion without conforming the design to the relaying device as was formerly the case. This new relaying device is said to have given in service considerably better results than have ever been obtained before by any other mechanism.

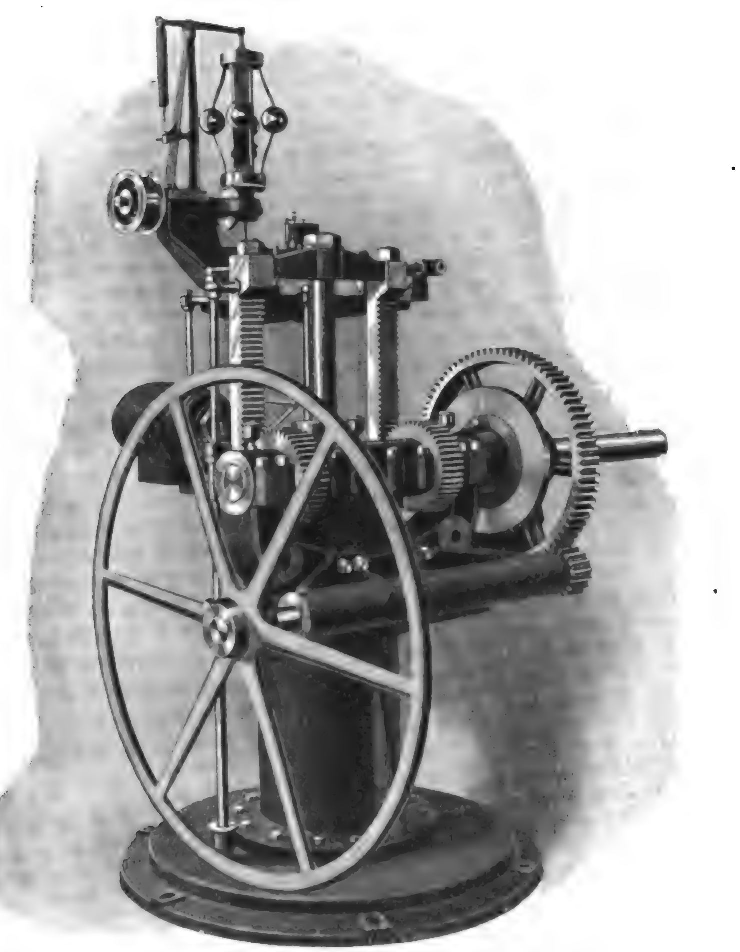


FIG. 1.—TYPE "N," LOMBARD WATER-WHEEL GOVERNOR.

The main valve of the governor consists of a large double hollow piston contained in the horizontal cylindrical case back of the hand wheel rim at the left of the engraving. The wearing surfaces of this valve are made of hardened steel and the cylinder in which it travels has a hardened steel sleeve or bushing through which the ports are cut. The valve itself is perfectly balanced, so as to require comparatively slight force to move it. Reliance is not placed, however, on this fact, but powerful hydraulic plungers, supplied from the pressure system of the governor, are provided to insure its movement. These plungers are under the simultaneous control of a very small primary valve attached to the stem of the centrifugal balls and of a small valveless displacement pump in the slender vertical cylinder at the left of the engraving. The piston of this pump is attached to and moves with the main piston of the governor. The relation of these parts is such that the least displacement of the primary valve by the centrifugal balls causes an instantaneous and positive movement of the large main valve. The main valve is immediately restored to its closed position by the action of the displacement pump as soon as the primary valve is again closed. There thus results an exact immediate magnification by the main valve of the movement of the primary valve, and this magnification is the principal reason for the accurate speed regulation given by this governor. In an ordinary hydraulic governor the least speed variation which will produce motion of the governor depends upon the lap of the valve controlled by the centrifugal weights; the smaller the lap the greater the sensitiveness. On the other hand, small lap of the valve is conducive to large leakage and short life. With the relay valve form of construction used in the Type N governor, the lap of the main valve influences in no way the sensitiveness of the machine and still insures freedom from leakage. In order to take the utmost advantage of this feature of its construction the Type N governor is provided with a primary valve having an outside micrometer adjustment for varying the amount of lap. By this means it is easy to alter the sensitiveness of the governor while it is running so that it will respond to speed changes of greater or smaller magnitude down to the limit where the governor is kept in motion by speed changes too small to detect. This micrometer adjustment also serves to take up the loss of lap of the primary valve due to wear.

The anti-racing mechanism of the Type N governor is of the well-known type used in Lombard governors for many years. Certain improvements have been made in the nature of adjustment and in design, however, so that the effect in making the governor dead beat is much more marked at the beginning of the stroke, when the water-wheel gates are just opening.

The capacity of the Type N governors is said to be much greater than that of any standard governor manufactured hitherto. The piston is 10 inches in diameter with a 24-inch stroke, and 200 lbs. per square inch is the normal pressure, so that the governor exerts 31,000 foot-pounds of energy per stroke. The factor of safety under this pressure is ample. Under emergencies the pressure has been increasd over 50 per cent without harm to the governor.

Persons actually interested in the object may be even more interested in seeing results obtained by the use of this governor than by a mere description of the machine itself. Any one feeling thus is cordially invited to visit the new Lombard factory at Ashland, Mass., where these governors may be seen under service conditions, regulating full-sized turbines. Fig. 2 is a *fac simile* of a speed recorder strip obtained in service with a Type N generator.

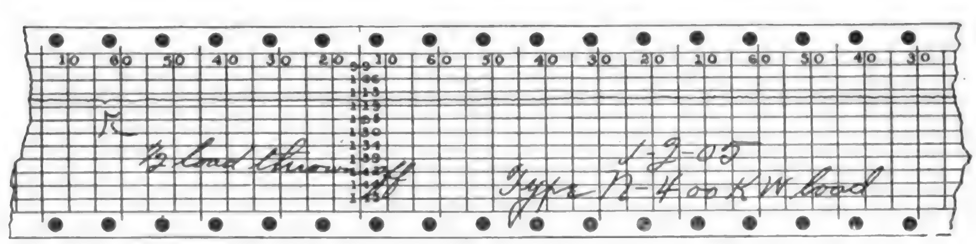


FIG. 2.—SPEED RECORDER STRIP.

New Apparatus and Appliances

MURRAY FEED-WATER HEATER AND PURIFIER.

The open feed-water heater and purifier, shown by Fig. 1 herewith, is made by the Murray Iron Works, of Burlington, Iowa. The supply is regulated by an automatic float valve which admits only as much water to the heater as the boiler requires. The water first passes over a series of removable pans which catch such impurities as precipitate at a temperature of nearly 212 degrees. From here the water passes to the settling chamber where oil and such other impurities as come to the surface of boiling water are skimmed off, the water being in contact with the exhaust steam from the engine all the time. The water thus purified passes to the pump suction chamber through a series of syphon goose-necks, which take the purified water from beneath the surface in the settling chamber only. Three-sixteenth-inch holes are provided in the goose-necks one-half inch above the main openings, so that the syphoning is stopped by the admission of air into the goose-necks when the surface of the feed-water falls below these holes in the goose-necks. The water in this chamber is kept hot by the exhaust steam pipe that passes through it. The heater, it is claimed, creates no back pressure, condenses part of the exhaust steam, purifies the feed-water as well as heating it to the maximum temperature attainable by this method.

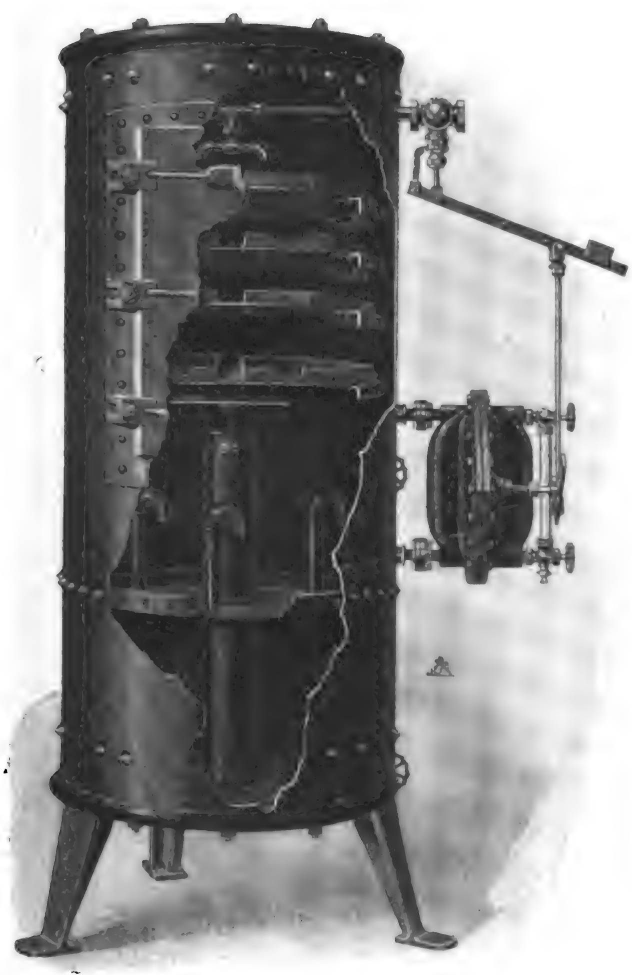


FIG. 1.—MURRAY OPEN FEED-WATER HEATER AND PURIFIER.

CONTROLLER FOR BOILER FEED PUMPS.

The controller for boiler feed pumps illustrated herewith is essentially a governor for the pump which is controlled by the relative pressure of the steam and water. This is made clear by reference to the illustration, from which it is seen that the working parts are a balanced valve and a differential piston. The initial steam pressure being on the ends of the valve, has access, through the neck, to the full area of the piston and will force it into a position giving a full valve opening, where it will remain until overcome by the water pressure from the pump acting against the opposite side, which is of reduced area. The excess pressure required to overpower the initial steam pressure is equal to the reduction of area on the water side of the piston; so that were the reduction 10 per cent., the water pressure must be 10 per cent. greater than the steam pressure to give the same thrust on the piston. When this pressure is reached the valve is held only wide enough open to admit steam to the pump to keep up this excess pressure. If this excess pressure should become greater, the steam valve is forced nearly closed, thus nipping the cause of the rise namely, too great a piston speed. The water-pressure varies only as the steam pressure varies, always keeping the same per cent. of excess. The controller is made by the Federal Valve Company, of Seattle, Wash.

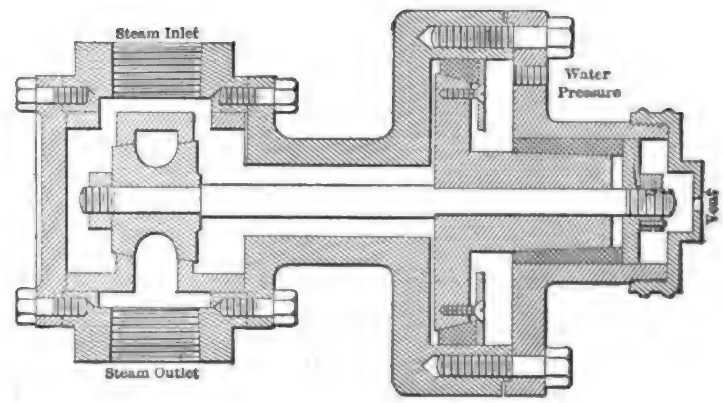


FIG. 2.—AUTOMATIC CONTROLLER FOR BOILER FEED PUMPS.

CHOKE COILS FOR PIPE THAWING OUTFITS.

Quite a number of thawing transformer outfits are now on the market, embodying more or less complicated regulating devices but it has seemed to some that it is needless to tie up a transformer to such intermittent service. Realizing that nearly all central stations carry a few reserve transformers for emergency requirements, the Peerless Electric Company, of Warren, Ohio, has brought out the regulating or choking coil shown by Fig. 3 herewith. The coil can be utilized with any make of standard transformer having sufficient size. This affords a most successful thawing outfit at moderate cost, and leaves the transformer available for ordinary use. The apparatus consists of two coils of heavy copper bar, having large carrying capacity, in connection with which are two plunger cores of laminated steel, to be raised from or lowered into these coils for the purpose of either increasing or decreasing the amount of current as desired for various

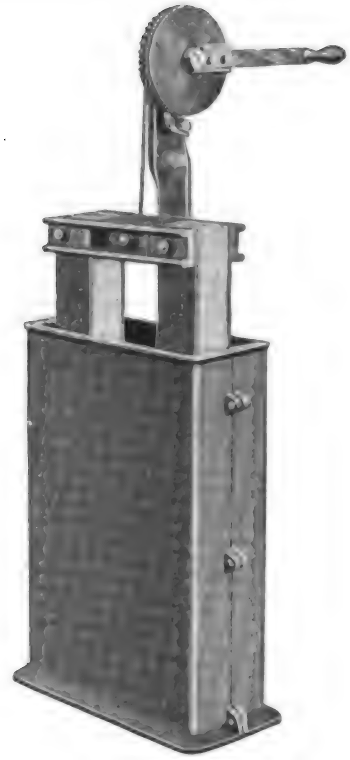


FIG. 3.—PEERLESS CHOKE COIL.

sizes and lengths of pipe. The current traversing the pipe is heavy enough to readily heat it to a degree of temperature for thawing purposes, but not to cause injury, even though this be very small iron or lead service pipe. The regulating coil is well made and exceedingly simple in its working parts. The windings are given an insulating treatment that renders them water-proof, and are enclosed in a strong iron case. The core is raised or lowered by a simple device, operated by a hand wheel with cable and ratchet attachment, which is strong and positive in its action. The apparatus is designed to be used with any standard 110-volt transformer, either 60 or 133 cycles, of capacity from 10 to 30 kilowatts. Properly installed in connection therewith, injury to the transformer from short circuit is impossible, as the choking effect of the coil is such that only normal current will flow in secondaries of transformer even though the leads be short-circuited when the plunger is inserted its full length in the regulator. The coils are equipped with heavy terminals for connecting up cable leads. Results vary so greatly, according to conditions, that a definite schedule covering exact working voltage, length and diameter of pipe and time necessary to thaw the same cannot be given; but the maker claims that with the choke coil herein described, the temperature of 100 feet of ½-inch iron pipe frozen solid can be raised 20 degrees in five minutes. There is no danger of ever melting the pipe, as the ice or water contained therein is an ample safeguard. As soon as the water begins to flow freely, the work is done. With each apparatus is furnished a blue-print plainly showing the connections to the choke coil and the transformer, and also containing full directions.

THE ZEEK BORING TOOL.

Fig. 4 herewith shows the Zeek boring machine manufactured by James McCrea & Co., Chicago, Ill. The device is intended

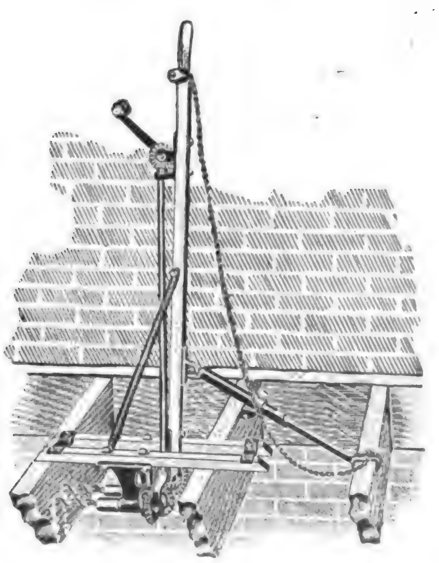


FIG. 4.—ZEEK BORING TOOL.

for boring holes below while standing on the joist. It bores two holes at once, 3¾ inches from center to center and 3½ inches from the top of the joist, which is a sufficient distance to void nails. The operation is said to be both easy and rapid, since the operator stands upright to his work. All holes are on a line, insuring a straight run of wire as well as all the other advantages of straight work. The method of operating the machine is clearly shown in the engraving.

NEW PROTECTED SWITCH.

William T. Pringle, of Philadelphia, Pa., has brought out the "Underwriters" switch shown by Fig. 5 herewith. The contacts are all protected with a porcelain cover, which does not have to be removed to op-

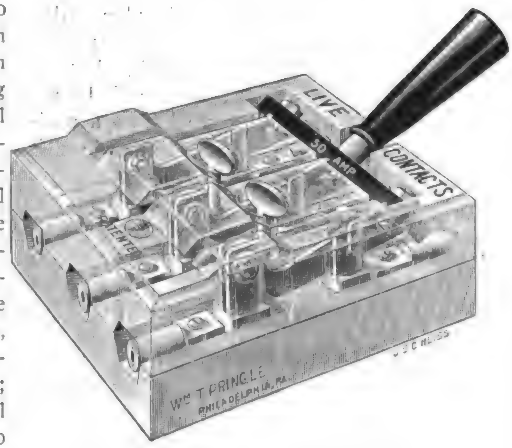


FIG. 5.—PRINGLE "UNDERWRITERS" SWITCH.

erate the switch, so that all liability of accidental contact is avoided. The metal parts are said to be strong and substantial and the contacts are set in grooves to insure perfect alignment. The contacts are made of rolled copper designed with ample margin of safety both for current and voltage. The switch is made for 25 and 50 amperes, both double and triple-pole.

EXPERIMENTAL DYNAMOS AND MOTORS.

The R. M. Cornwell Co., of Syracuse, N. Y., is putting on the market a complete line of experimental dynamos and motors from the smallest made up to a 1-kw. machine for commercial purposes. The accompanying illustration shows the "Wonder" dynamo, which is claimed to be the smallest generator of its kind on the market. It has an output of about 12 watts, and is wound for a number of different voltages

FIG. 6.—EXPERIMENTAL DYNAMO.

In bringing out this machine it was the aim of the company to put on the market a small generator following in every detail the construction of large commercial machines. Among its special features are its laminated armature, adjustable brushes, large and strong commutator, heavy interchangeable bearings. The machine is for use where a small amount of current or power is required, especially in connection with experimental work. As a motor the machine is said to operate running light on about 2 watts, and with sufficient battery will do a considerable amount of work for its size. The machine is also wound to run in series on 110-volt lighting circuit. All parts are interchangeable.

HORNBERGER-IRWIN TRANSFORMER.

The accompanying illustration shows the multi-coil core type of Hornberger-Irwin transformer made by the Crawfordsville Electric Company, of Crawfordsville, Ind. This is the style of construction used in all but the smaller sizes of transformers made by the company. By reason of this practice the difference of potential between layers at the end of the coils is reduced to a minimum, it is claimed, and the low temperature of the core maintained since it is directly exposed to the radiating medium at intervals through its entire length. A sheet steel case is used on transformers from 20 kilowatts to 100 kilowatts. This is not only less weighty than a cast iron case, but also dissipates the heat more rapidly. For sizes larger than 100 kilowatts, the case is corrugated. The complete transformer being made up of many coils, each having the required number of ratio turns within itself, all coils being then connected in multiple to the terminals, a possible disablement of one coil does not mean that the transformer must be entirely replaced; but only that coil

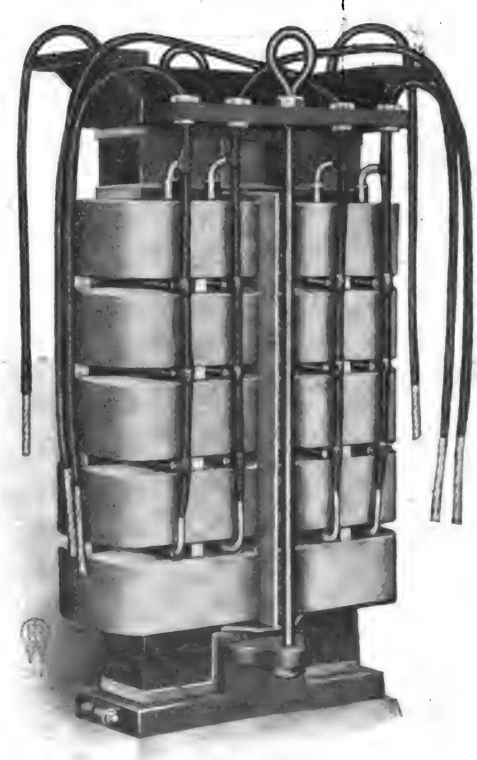


FIG. 7.—HORNBERGER-IRWIN TRANSFORMER.

which might be injured. As the correct terminal voltage is obtained, even were a number of coils removed from the transformer, its operation is affected only to the extent that its capacity would be reduced

by the number of coils not in operation. The company claims to have overcome the objections usually made against the core type of transformer, *i.e.*, the excessive voltage between layers at the end of the coils, and the internal temperature. All transformers are carefully tested before shipment. A break-down test of 10,000 volts is applied between the primary and secondary windings, as well as between the windings and the core. Electrolytic copper and mica are used for conductors and insulation throughout.

BALL BEARINGS FOR ELECTRIC MACHINES.

The Hess-Bright Manufacturing Company, Philadelphia, Pa., are introducing the ball bearing shown by Fig. 8 herewith. In this type of bearing the racers are without joint or opening of any kind, so that the bearing can be used without reference to the direction of the load, or whether it is the shaft or the hub that revolves. The balls are separated by interposed springs. When these are compressed the inner race can be pushed over eccentrically so as to permit the balls to be inserted or removed. The number of balls is, therefore, less than with the "full type" bearings, the decrease in carrying capacity being compensated for by increased ball diameter. At high speeds this type of bearing is claimed to be absolutely silent. A wool pad in the spring between the balls soaks up oil, and will keep the ball sufficiently lubricated in case of neglect. The bearing takes up only a small space endwise; including the oil-retaining and dust-excluding arrangements, this is said to be less than the width of framing necessary to sustain the hub receiving the bearing. The races are made from high-grade steel; likewise the balls. The races are ground close to size as concerns their seat on the shaft and in the box, so that interchangeability is assured. The ball tracks are accurately ground to shape and polished. The company also makes the "full type" of roller bearing. In this type the balls are filled in through an opening in the side of the race, which is closed by a screw or clip through which the race is ground. The advantages claimed for the "Universal" type are the following: Small friction; small oil consumption; small wear; small space occupied; small attention, and convenient exchange. Fig. 9 shows the ball bearings applied to the shaft of an armature built by the Electro-Dynamic Company, of Bayonne, N. J.

FIG. 8.—"UNIVERSAL" BALL BEARING.

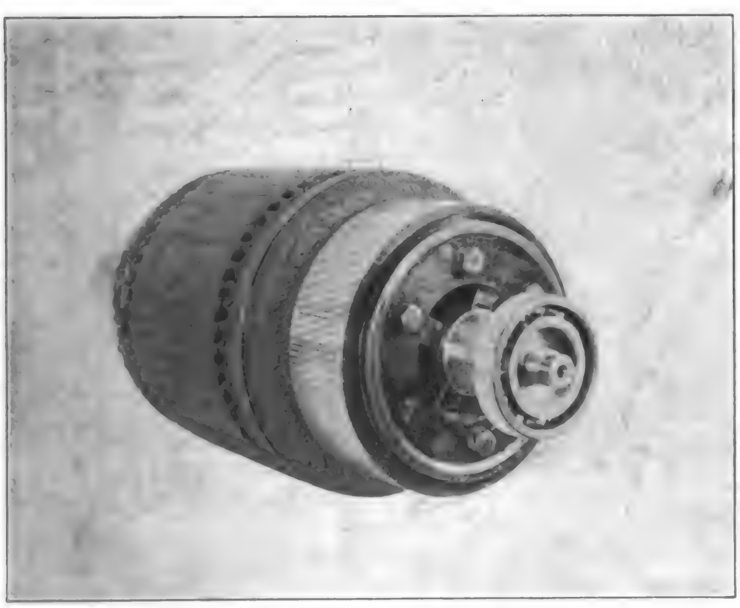


FIG. 9.—BALL BEARING APPLIED TO SHAFT OF ARMATURE.

AUTOMATIC BOILER FEED REGULATOR.

The Copes automatic boiler feed regulator consists essentially of two parts—the feed controller and the pump governor. The regulator is placed entirely outside the boiler, and consists of nothing but copper tubes, check valve, toggle, cylinder and piston. The connections are shown diagrammatically in Fig. 10. A ¾-in. copper pipe, 6 ft. long, is screwed into a special fitting at the lower left-hand corner at about a 30-deg. angle, to allow all condensation to return through the horizontal pipe to the boiler.. This constitutes the feed controller. The water column is tapped at the water level of the boiler and a ¼-in. pipe is connected as shown. Steam entering the copper pipe causes the latter to expand and open the check valve through the intervention of the lever to which it is attached. When this check is released, the pressure in the feed line is less than the steam pressure, thereby causing the piston of the pump governor to rise and admit steam to the pump. As soon as the water in the boiler covers the opening tapped in the water column, the expansion tube contracts and the check valve is closed. This causes the piston of the pump governor to shut steam off the pump. The agents for the regulator are Thorpe, Platt & Co., New York City.

ELECTRIC BLUE-PRINTING MACHINES.

Fig. 11 herewith shows an electric blue-printing machine made by the Buckeye Engine Company, Salem, Ohio. Each machine is equipped with two rollers, one on each side, which carry the contact curtain and are operated independently, so that just one side may be used and one side may be unloaded and reloaded while the other is printing. The contact curtain is held firmly to the surface of the glass by means of weights attached to small wire cables engaging both ends of the rollers which carry the curtain. By this arrangement perfect and even contact over the entire surface of the glass is said to be secured. No buttons or clamps or any mechanism whatever is required for fastening the curtain to the frame, and holding it in place after it has been unrolled. The rollers, it is claimed, remain stationary at any point on the circle and the curtain back of the roller is in perfect contact with the glass regardless of how far it has been unrolled. The lamp furnished with the machine is especially constructed for photo-engraving and blue-printing work. It is of the long-arc construction transmitting a light rich in actinic or violet rays. A lamp is furnished to operate on either direct or alternating current, and at any voltage. A rheostat is furnished with each lamp to adapt it to the current desired. The pendulum governing the drop of the lamp is adjustable as to speed, thus removing the necessity of making more than one drop of the lamp at a printing, regardless of the condition of the tracing. The roller device is so constructed that the machine may be readily loaded and unloaded while the glass cylinder is in the vertical position. All arrangements for tilting the frame to a horizontal position

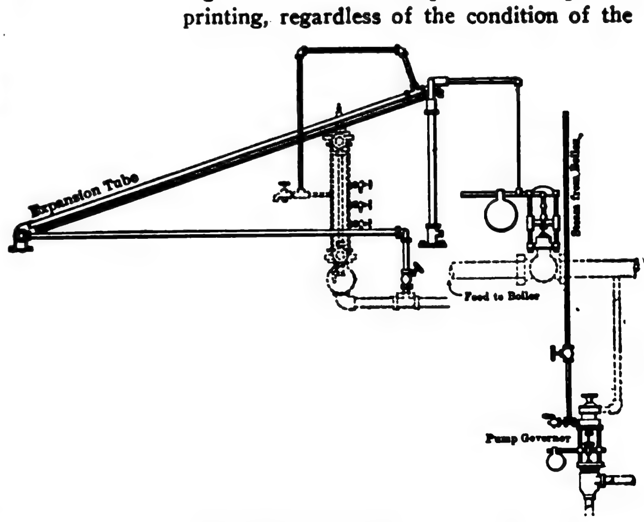


FIG. 10.—AUTOMATIC BOILER-FEED REGULATOR.

are dispensed with. The operation of the apparatus calls for no particular skill and

FIG. 11.—BUCKEYE BLUE PRINTING MACHINE.

requires the attention of but one person in connection with his other work, or it can be manipulated by a boy as satisfactorily as by a skilled workman. The machine is made in two styles, designated A and B; the first making prints 42 ins. by 44 ins., and the second making prints 42 ins. by 60 ins. The machine requires a floor space of 3½ by 3½ feet, and the height over all is 9 feet.

PORTABLE ELECTRIC GENERATING SET.

The accompanying engraving shows a portable electric generating outfit consisting of a 4-h.p. Mietz & Weiss oil engine, belt-connected to a 2¼-kw. General Electric generator. The engine uses ordinary kerosene oil and has a fly-wheel governor instead of the hit-and-miss type of governor generally used, so that the regulation is said to be quite close, and, of course, suitable for electric generating purposes. The operation of the Mietz & Weiss oil engine is so well known that its repetition would be superfluous. Tests made on the engines driving dynamos have been repeatedly made and show that the speed variation between no load and full load is very slight. The builder of the engine, A. Mietz, of New York City, informs us that the Japanese government is using sixteen 4-h.p. stationary Metz & Weiss oil engines.

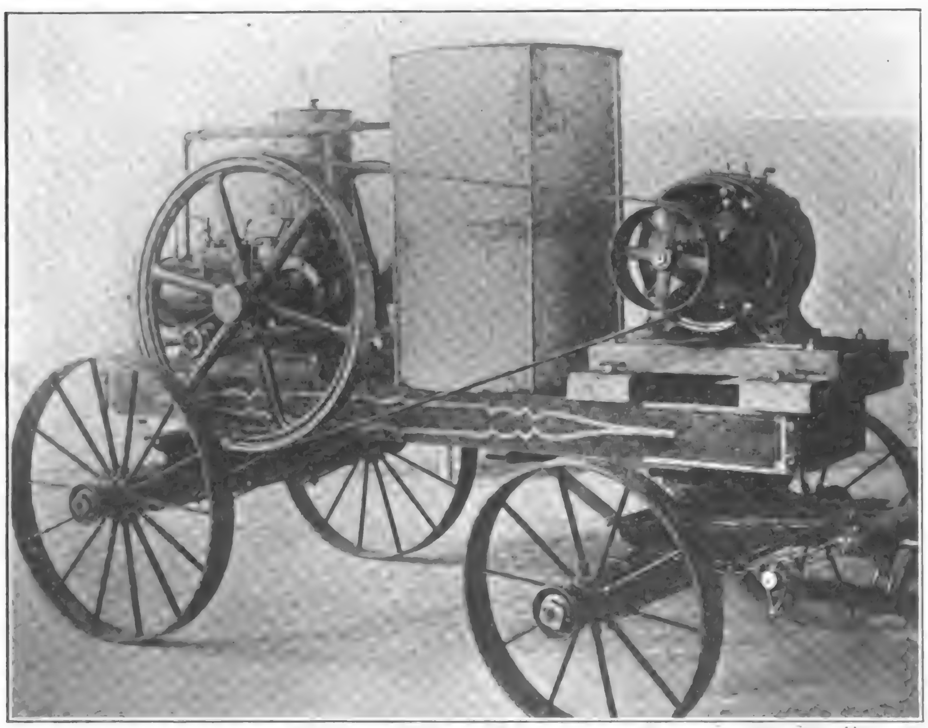


FIG. 12.—PORTABLE ELECTRIC GENERATING SET.

LOS ANGELES-PACIFIC RAILROAD.

Owing to the greatly increased traffic on the interurban railway system of the Los Angeles-Pacific Railroad Company, the officers of that company have decided to increase the capacity of the central power house at Vineyard, and to install an additional sub-station in Los Angeles. The new electrical equipment has been contracted for with the Crocker-Wheeler Company through its Pacific Coast managers, the Abner Doble Company, of San Francisco. The contract comprises one 1200-kw., three-phase, 50-cycle, engine-type generator to give 2300 volts at a speed of 125 r.p.m.; one 300-kw. motor-generator set; one 400-kw. motor-generator set; three 400-kw. transformers; three 160-kw. transformers; three 120-kw. transformers, and a 60-kw. engine-type exciter. The 1200-kw. alternator will be of the Crocker-Wheeler new revolving-field type, similar in construction to the three 4000-kw. alternators recently ordered by the California Gas & Electric Corporation. The Los Angeles generator will be driven by a 2000-h.p. compound condensing McIntosh & Seymour engine. The motor-generator sets will consist of 2300-volt synchronous motors driving 600-volt direct-current railway generators. The transformers will be built for 15,000 volts at the primary and 2300 volts at the secondary terminals, and will be of the new water-cooled and oil-insulated type recently brought out by the Crocker-Wheeler Company.

The interurban railway system of the Los Angeles-Pacific Railroad Company is one of the most extensive in the country, embracing as it does nearly 200 miles of up-to-date lines. The company owes its growth largely to the energetic and untiring work of the president and manager, Mr. E. P. Clark, who was one of the pioneer railway men of Southern California, and who has seen his system develop from a very small beginning to its present commanding position in the traction field. The system extends from Los Angeles in fan shape to Santa Monica, Ocean Park, Playa del Rey, Hermosa, Manhattan Beach, and Redondo on the ocean, and passes through the intermediate towns of Hollywood. Colegrove, Sawtelle, Sherman and Palma. In other words, the lines cover thoroughly the territory lying south of the Santa Monica Mountains, and between Los Angeles and the ocean. Most of the lines have been double-tracked, and are constructed in conformity with the best steam railroad practice. About a year ago a new central steam-driven power plant was installed at Vineyard about 5 miles west of Los Angeles, and from this station 15,000-volt transmission lines carry power to several sub-stations located at intervals over the system. It is to increase the capacity of this central power station that the additional machinery mentioned has been ordered.

ANNUAL DINNER OF THE AMERICAN TRADE PRESS ASSOCIATION.

The American Trade Press Association held on February 17th what was designated by Mr. J. H. McGraw, the president of the association, as the most successful annual meeting in the history of the organization. The meeting began with the usual banquet, at which Mr. Arthur Warren, manager of the Allis-Chalmers Company's publicity department, was the principal guest and speaker. After due attention had been given by those present to the fine collation provided by the association, Mr. Warren delivered his address, the subject of which was "A Plain Talk on Trade Journals." It was by all odds the most pithy, vigorous and non-evasive discussion of the relations between technical periodicals and their advertisers that the present writer has ever heard or read. Space limitations preclude reprinting here the complete address, but the following excerpts will illustrate the general character of it:

Industrial publicity is a new thing; it is young and still learning to walk. It sometimes seems that no one appreciates the possibilities of publicity so much as the Publicity Man himself, and its appreciation in the industrial field is a thing of yesterday morning. There is no industry, among all those represented on this occasion, that has all the publicity it needs. There is no metal-working manufactory that spends money enough on publicity. Manufacturers are accustomed to say "Publicity costs so-and-so." They are not yet accustomed to think "Publicity earns so much."

Advertising is not the mere purchase of space, but the handling of it. It costs something to handle space.

The world rains "special numbers." The special number has become as much of a burden to the flesh and spirit as the Sunday paper. It has become only another name for special pleading for extra advertising. It has been overdone.

Of the publisher who says I must advertise in his paper because I do so in his competitor's pages, and that he is "entitled" to advertising to the same extent—what shall I say? Least said, soonest mended.

Believe me when I say "Don't cut your advertising rates." Make your paper so strong in character, so attractive in contents, so necessary in information that the people it is designed for must buy every edition. Then advertisers must buy space, not because you plead with them, but because they have no alternative.

There is one nuisance that we all know about, and that is the "write-up." It is a nuisance to all concerned, and of value to none. But there is a vast difference between the "write-up," dreary, fruitless, bald and undisguised, and the timely article that has news value or interest for the commercial or industrial world. These articles are legitimate if they are well-written and informing.

There should be, and can be, closer touch between the papers and the manufacturers, and it can be obtained without the loss of independence by the press. The papers that are not independent—that are partisan and that curry favor—are the papers we don't want.

In trade and technical journalism there is one deep, elusive mystery—circulation! But the time has come when the veil must be rent. Advertisers are entitled to know the facts of circulation; they have the right to know what they are buying. You may print many copies, but how many do you sell? In other lines of business the seller has to give written guarantees. Why should publishers be exempt?

A highly interesting discussion followed the delivery of Mr. Warren's address. Two publicity managers from representative manufacturing establishments were present, and both supplemented Mr. Warren's advocacy of editorial independence by stating that the best results that their respective companies had obtained from advertising were from papers which were absolutely rigid in declining to recognize any "rights" on the part of advertisers to the use of the reading columns, and which invariably refused to publish in the reading pages any material in violation of their editorial policies.

Several well-known publishers of trade periodicals disagreed with Mr. Warren on the question of stating the paid circulation of a paper. Mr. David Williams, of the *Iron Age*, and Mr. Angus Sinclair, of *Railway and Locomotive Engineering*, said that they had never found it necessary to state circulation. Mr. Sinclair had tried it for several years and found no advantage from it, and as it entailed a good deal of extra work to get at the exact figures, he discontinued the practice. Messrs. John Hill, president of the Hill Publishing Company, and James H. McGraw, president of the McGraw Publishing Company, both favored the statement of circulation.

THE NEW FACTORY OF THE LOMBARD GOVERNOR COMPANY.

In the commercial world just as in the physical world the best measure of success is growth. By this measure the Lombard Governor Company has forcibly demonstrated the success of its products through the notable enlargement of manufacturing facilities which has been made necessary. Formerly the headquarters of this company were at 36 Whittier Street, Boston, Mass., in a good-sized but rather old-fashioned shop, where something like five floors were occupied by various departments. There was room to spare, at first, but as the demand for its products grew, it was found necessary to crowd the machinery, until finally the work could not be carried on to the best advantage. For the past two years, night work has been necessary part of the time in the whole shop, and certain machines have been running all day and all night for more than a year past. The demand for the highest grade of governors is still growing, and the company has really been forced to leave its old quarters.

The engineers of the company for a long time have desired to obtain facilities for testing its products under actual service conditions in its own shops. This has not been possible heretofore, although ingenious electric equivalents for hydraulic testing were in service. A group of fine stone buildings, situated on the Sudbury River, in the town of Ashland, Mass., was finally selected as giving all that could be desired from a manufacturing and engineering standpoint, and two months ago the Lombard Governor Company began moving into this plant. These buildings were put up at a cost of over $500,000 by the Dwight Print Works for the purpose of making print cloths. Before being entirely completed, the Sudbury River was seized by the Metropolitan Water Board to furnish drinking water for the city of Boston. This, of course, prevented the use of the mills for the original purpose, and they have lain idle in a nearly complete state for several years. The prohibition put on the pollution of the water, however, did not apply to the use of water for power purposes, and, therefore, for hydraulic testing, almost unequaled facilities are offered at this place. The volume of water flowing is sufficient for the greater part of the year to drive the entire plant, but a first-class 150-h.p. steam plant is held in reserve at all times.

The main shop, of granite, is three stories high, 210 ft. long and 60 ft. wide. The floors are without partitions, and are perfectly open except for offices and draughting room on the upper story. Slow-burning construction has been employed, which, with massive granite walls two feet thick, eliminates most of the risk from fire. The power house, also of granite, is alongside the main mill, and has a storage capacity for 1000 tons of coal—sufficient for a year's supply. In addition to these principal buildings there are a good-sized pattern and blacksmith shop where the water-wheels are located. The property includes all power privileges on the stream, a mill pond adjacent to the factory buildings, and another two miles up stream.

The main building is unusually well-lighted. The middle floor, which is about four feet above the street level, is utilized for the most important machine work. On account of the great width and length of the building, the machines, which in the old factory were located with reference to the space available, are here put in the most advantageous positions, both as regards light and the progress of the product in course of manufacture. A spur track from the New York Central Railroad delivers goods on the level of this floor at the front door of the building. Finished material and the more valuable supplies are kept in a large stockroom just at the left of the entrance. The office of the foreman and shipping clerk forms an extension of the stockroom. The tool room is located in the middle of this floor, where the average distance from the operatives will be the least. The draughting room, about 40 by 30 feet in size, is at the front end of the third floor where north light is available. The offices, adjacent to the draughting room, are very commodious.

An isolated lighting plant and connection with the Edison system of Boston have been provided. Intercommunicating telephones are used throughout the plant. Special cut-off couplings are arranged so that power may be taken either in whole or in part from the engine or water-wheels, and a load of any desired character may be thrown upon the water-wheels in order to test governors which are connected with them.

The hydraulic equipment will consist of two wheels of standard make running vertically in an open forebay with plate glass sides and end. This forebay will be well inside one of the buildings so that it will be open for inspection at all times regardless of the weather. When daylight does not furnish sufficient illumination, electric lights located under the water will make it possible to observe the action of the wheels and the gates. Means are provided for controlling either one or both wheels by

either one or two governors. It is thought that this is the first instance where full sized turbines operating under commercial conditions have been installed so that their action is made visible to the smallest detail while running. Thus the entire collection of mechanism, including the governors, may be kept under constant observation.

Excellent shipping facilities are afforded at Ashland by the main line of the Boston & Albany Railroad (controlled by the New York Central), and also by the New York, New Haven & Hartford Railroad, of which it is a terminus. Visitors may reach the factory from Boston or Worcester, via the Boston & Albany Railroad, after a forty-five minutes' ride in either case. It is also accessible by several lines of electric cars.

NEW BOOKS.

SCIENTIFIC AMERICAN REFERENCE BOOK.—Compiled by A. A. Hopkins and A. R. Bond. New York: Munn & Co.; 1905. Buckram; 516 pages, 5 ins. x 7½ ins.; illustrated. Price, $1.50.

This is a compilation of interesting information of almost every conceivable class. The scope covers the progress of discovery, shipping, navies and armies of all countries; railroads; population of the United States; libraries, publishing and printing; modes of communcation; patents, manufactures; governmental departments; mining; elementary geometry; machine elements; mechanical movements; chemistry; astronomy, and weights and measures. The technical information is given in a more or less popular style; in some cases it is very academic and in a few perfunctory—that is, merely the old hack material found in every engineers' handbook thus far published. The few pages of mathematics relating to geometrical figures are of questionable accuracy; the reviewer notes two errors in merely glancing through this section. The book contains a mass of really useful data, however, and should prove at least interesting if not always helpful.

STANDARD WIRING FOR ELECTRIC LIGHT AND POWER. (11th Edition.) By H. C. Cushing, Jr. New York, 1905: Published by the author. Flexible leather; 144 pages, 4 ins. by 6½ ins.; illustrated. Price, $1.

This edition of Mr. Cushing's well-known wiring book shows evidence of extensive revision. Several pages of connection diagrams have been added; also a chart showing the current-carrying capacity of weather-proof and rubber-covered wires according to the Underwriters' requirements, and a special section, by Mr. George T. Hanchett, on alternating-current wiring. The abstract of the Underwriters' Rules, which has always been the chief feature of the book, has been revised, of course, to accord with the changes in the Rules this year. This work had the able supervision of Mr. F. E. Cabot, chairman of the Underwriters' Electrical Committee. It is noted with some surprise that the author retains the symbol *C* in his formulas, instead of the recognized symbol *I* for current in amperes; also that the table of motor efficiencies on page 23 is rather rough-hewn, the efficiency of a 5-h.p. motor being put at 80 per cent., and that of a 10-h.p. machine (no intermediate size being given) at 90 per cent. This might easily have been made more nearly accurate without any "hair-splitting" whatever.

CYCLOPAEDIA OF APPLIED ELECTRICITY. Chicago: American School of Correspondence. Cloth; five volumes; 2154 pages, 6¼ ins. x 9½ ins.; numerous illustrations. Introductory price, $18.00.

This is a collection of writings by an imposing corps of well-known contributors to current technical literature, including, for example, Profs. F. B. Crocker, William Esty and Dugald C. Jackson; and Messrs. J. R. Cravath, Percy H. Thomas and Alfred E. Zapf. The contents in the main consists of very useful data and expository matter, and while much of the material is academic and some of it a trifle out of date, it appears to be generally accurate. The scope of the work is enormous, covering as it does, the whole domain of applied electricity. Its avowed mission seems to the reviewer to be over-ambitious in including designers and constructors of electrical machinery in its audience; it is safe to assume that the books will be absolutely useless to both classes of men, especially the designers, who have long ago tabooed the method of dynamo design adopted here. To operators of electrical machinery and apparatus, and practical workers who have not had collegiate training, the work should be of considerable value if used discriminatingly. The sections on alternating-current machinery, storage batteries and telephone engineering are especially good; most of the other sections suffer from too much catalogue rehash, and the dynamo design section is unqualifiedly worthless. The books contain, however, a great quantity of data which is of use to engineers generally, and which may make the work useful for reference to many who do not need it educationally.

ELECTRICAL ENGINEERING EXPERIMENTS. By George F. Sever. New York: D. Van Nostrand Company; 1904. Heavy paper covers; 64 pages, 5½ ins. x 8½ ins.; 22 illustrations. Price, $1.

This is avowedly a compilation of tests for direct-current machinery, the material being arranged for third-year students in Electrical Engineering at Columbia University. Inspection of the contents arouses the suspicion that the students are not expected to have progressed very far during their first two years. The tests are all useful and familiar, but most of them are of the simplest possible character and some of the instructions well suited to the intelligence of an oiler in any modern central station. The table of symbols on pp. 6 and 7, said to be in conformity with the recommendations of the American Institute Committee on Standardization, is inaccurate in some particulars; the type face used for the magnetic symbols is not that recommended by the American Institute, excepting the permeability symbol; maxwells are called webers, and several symbols which were not even suggested by the Institute Committee are included in the table. The diction is loose throughout the book; "fields" is used instead of "field winding," for example, and on page 56 we are told that when two compound-wound dynamos are connected in parallel, with the usual equalizer, if the series windings have the same resistance the total current will divide equally between them, "making the ampere-*turns* similar." Italics ours. However, the book should be useful to those having to do with direct-current machinery and not having had the advantages of a technical education, but its price is out of all proportion to its value.

OBITUARY.

EUGENE F. PHILLIPS, general manager of the American Electrical Works and president of the Washburn Wire Company, Phillipsdale, R. I., died on February 22, of combined pneumonia and heart trouble, after a very short illness. Mr. Phillips was one of the most progressive and prominent wire manufacturers in this country, and his unusual business ability and genial personal qualities had made warm friends for him throughout the electrical industry. He was 61 years old at the time of his death. He leaves a widow and two sons, who have the sincere sympathy of a large proportion of the electrical fraternity, including the writer of this paragraph.

PERSONAL.

MR. R. B. McCONNEY, an engineer well known in the Colorado mining district, has been appointed manager of the Denver office of the Allis-Chalmers Company, to succeed Mr. R. J. Cory.

MR. FRANK H. GALE, who has been a member of the General Electric Company's publicity staff for several years past, has been appointed manager of the company's New York branch of that department.

MR. H. H. PEASE, who has been connected with the Nernst Lamp Company for some time past, has been appointed district representative of the C. & C. Electric Company at Pittsburg. His offices are in the Park Building.

MR. THOS. FERRIS, formerly the Milwaukee representative of the General Electric Company, has acquired an interest in the Osage (Iowa) Electric Light, Heat & Power Company and assumed the management of the property.

MR. W. N. STEVENS, for some time on the engineering staff of the Rapid Transit Subway Company, has accepted a position on the staff of J. G. White & Co., New York. Mr. Stevens is widely experienced in the design and construction of important power plants.

MR. CHARLES W. CROSS, formerly of the staff of the Roberts & Abbott Company, Cleveland, Ohio, and later the engineer of the Eastern Ohio Traction Company, has accepted a position with the Cleveland branch office of the Crocker-Wheeler Company.

MR. A. W. WYCKOFF has been appointed district manager for the National Electric Company at Pittsburg, Pa. Mr. Wyckoff has many friends in the Pittsburg section, having represented the Bullock Company there very effectively prior to the present appointment.

MR. H. S. REYNOLDS, who represented Stone & Webster's interests in Columbus, Ga., for several years, has severed his connection with that firm to accept a position on the operating staff of J. G. White & Co. His headquarters will be at the firm's New York offices.

MR. C. A. MORENO, for some time past chief engineer of the United Railways Company, St. Louis, Mo., has resigned that position to engage in consulting engineering on his own account. He was presented with a handsome silver dinner service last month by the officials of the company on the occasion of his relinquishment of his position.

MR. FREDERIC NICHOLS recently delivered an extremely interesting address before the Em-

pire Club, Toronto, Can., on "Niagara's Power, Past, Present and Prospective." The address has been reprinted in pamphlet form in very elegant style.

MR. JOHN BLAIR MACAFEE, the well-known Philadelphia engineer, has added to his other interests the engineering supervision of the work of the York (Pa.) Intramural Street Railway Company, York Railway & Electric Company; York, Hanover & Western Street Railway Company, and the King Street & Carlisle Avenue Street Railway Company.

MR. E. J. PIETZCKER, who has been a member of the Standard Underground Cable Company's Western Sales Department for several years, has been appointed manager of the company's new office at St. Louis, Mo. Mr. Pietzcker has had many years of experience in the wire and cable business and has many friends in the St. Louis territory who are glad to welcome him back.

MR. W. F. GRADOLPH, formerly chief engineer for the Central Telephone & Electric Company, St. Louis, has resigned that position to engage in consulting and contracting engineering. He has established an office at 2908 St. Vincent Avenue, St. Louis, and while he will make a specialty of telephone work, he will not restrict his field to this branch but will undertake contracts for electric lighting and power equipment, etc.

MR. CHARLES H. BAKER, who has been the president and chief engineer of the Snoqualmie Falls Power Company, Seattle, Wash., ever since he founded it six years ago, has sold out his interest in the company and retired from its management to take a thorough rest. He contemplates a trip to China and Japan chiefly for pleasure, but expects to keep an eye open for possibilities in the way of hydraulic-electric enterprises.

TRADE PUBLICATIONS.

REMOTE-CONTROL RHEOSTATS. General Electric Company.—Bulletin 4398, containing an illustrated description of field-circuit rheostats for operation from a distance.

AUTOMATIC BOILER FURNACES. The Model Stoker Company, Dayton, Ohio.—A catalogue of standard size, describing the new Model automatic stoker manufactured by this company.

MACHINERY AND TOOLS. Brown & Sharpe Manufacturing Company, Providence, R. I.—This is the 1905 edition of the well-known pocket-size catalogue which this company has issued for many years past.

POLYPHASE WATTMETERS. Fort Wayne Electric Works, Fort Wayne, Ind.—This is bulletin No. 1061, containing an illustrated description of the type K polyphase induction watt-hour-meter manufactured by this company.

N. L. C. CENTRAL STATION BULLETIN. Nernst Lamp Company, Pittsburg, Pa.—A monthly publication in bulletin form, the object of which is to familiarize central station men with the merits and possibilities of Nernst lamps.

ELECTRICAL LABORATORY APPARATUS. C. H. Thordarson, Chicago.—A catalogue of convenient size, containing illustrated descriptions of experimental apparatus, high-potential transformers, special spark and impedance coils, etc.

TELEPHONE APPARATUS. The Kusel & Kusel Automatic Switchboard Telephone Manufacturing Company, Chicago.—A catalogue of folio size, containing illustrations of telephone switchboards, instruments and switchboard fittings.

PIPE AND BOILER COVERINGS. The H. W. Johns-Manville Company, New York.—A nicely-executed vest pocket pamphlet, containing illustrations and brief descriptions of the well-known line of pipe and boiler coverings manufactured by this company.

PURCHASERS OF IDEAL ENGINES. A. L. Ide & Sons, Springfield, Ill.—An astonishingly long list of industrial establishments, mines, central lighting stations, hotels, distilleries, street railways and other enterprises using the well-known Ideal automatic engine.

CRANE MOTORS. Westinghouse Electric & Manufacturing Company.—This is circular No. 1097, containing a well-illustrated description of the Westinghouse type K direct-current series-wound motors for crane, hoisting and similar classes of service.

USEFUL LIGHT. The Shelby Electric Company, Shelby, Ohio.—A catalogue containing illustrated descriptions of the well-known line of Shelby lamps, with the usual forcible arguments in favor of the downward distribution peculiar to the standard Shelby lamp.

THE PIGEON HOLE. The Peerless Electric Company, Warren, Ohio.—A folder printed on light cardboard and devoted to the excellent line of stationary motors built by this company. "The Pigeon Hole" is issued monthly, each number relating to some product of the Peerless Company.

TELEPHONE APPARATUS. The Wesco Supply Company, St. Louis, Mo.—This is bulletin No. 61, devoted to the Wesco "Express" switchboard and parts, and bulletin No. 62, containing illustrated descriptions and price-lists of telephone instruments, magnetos, complete sets, and parts.

STORAGE BATTERIES. The Electric Storage Battery Company, Philadelphia, Pa.—Price lists "A," devoted to the "Chloride" accumulator, and "X," devoted to the "Exide" battery. The catalogues have been thoroughly revised and brought up to date, and are handsomely executed.

ELECTRICAL SPECIALTIES. The Appleton Electric Company, Chicago.—This is catalogue No. 2, of convenient pocket size, devoted to electric lighting and telephone specialties and supplies. The telephone specialties include a line of new lightning arresters of the combined carbon and fuse type.

STEAM TURBINES. The Westinghouse Machine Company.—A handsomely-executed book of standard catalogue size, containing a profusely illustrated description of the Westinghouse-Parsons turbine in its latest development, together with some interesting records of efficiency tests made on turbines of different sizes.

ELECTRIC STORAGE BATTERIES. National Battery Company, Buffalo, N. Y.—Catalogue No. 13, in which are described and illustrated the National battery for electric vehicle service, and catalogue No. 14, devoted to the company's standard stationary type of accumulator. The catalogues are both of standard size and handsomely executed.

WATTMETERS AND HOW TO READ THEM. Westinghouse Electric & Manufacturing Company.—This is designated Folder No. 4032, but is in fact a well-executed pamphlet of vest-pocket size, containing very clear instructions for the reading of watt-hour-meter dials, together with illustrations of Westinghouse Type A and Type B watt-hour-meters.

AUTOMOBILE CHARGING EQUIPMENTS. General Electric Company.—This is bulletin No. 4402, containing an illustrated description of very compact switchboards for use in charging automobile storage batteries. To the switchboard which has been heretofore used the company has added a mercury arc rectifier with auxiliary appliances, which, of course, allows the charging to be done from an alternating-current circuit.

THE STANDARD MOTORS AND GENERATORS. The Robbins & Meyers Company, Springfield, Ohio.—This is price-list P-20, containing illustrations, tabulated data and other information concerning the well-known line of Standard dynamos and motors built by this company. The catalogue is of standard size, well executed, and its contents are most conveniently arranged. Having an unusually large number of frames, the company is able to give several ratings at each output, so that the purchaser has a wide range of choice.

BUSINESS NEWS.

HENRY C. TULLEY, St. Louis, Mo., has issued a booklet relating to his Engineers' Handbook, which is entitled "A Business Proposition."

THE A. D. GRANGER COMPANY, New York, has established a branch office at Pittsburg under the management of E. W. Bentley, with headquarters in the Bessemer Building.

LAGONDA MANUFACTURING COMPANY, Springfield, Ohio, announces that a large order was recently received through its New York office for a shipment of its boiler-tube cleaners to go to Tokio, Japan.

STANDARD UNDERGROUND CABLE COMPANY, Pittsburg, Pa., has established a branch office at 521 Security Building, St. Louis, Mo., which will have charge of all the company's business in the southern and south-western territory.

LIONAIS & POULIN is the style of a new firm of electrical contractors which has established headquarters at 242 St. James Street, Montreal. The firm makes a specialty of armored and decorative work, but takes contracts and does repairs of all kinds.

THE ROBBINS & MYERS COMPANY, Springfield, Ohio, has received from the St. Louis Exposition authorities the highest awards in their classes for its well-known and widely appreciated dynamos, stationary motors and ceiling and desk fan-motors.

SPRANLEY & REED, of New Orleans, have been appointed district representatives of the National Electric Company, Milwaukee. The firm has had wide experience in the electrical field in and around New Orleans, having been formerly the representatives of the Bullock Company.

EMPIRE STATE DRY BATTERY COMPANY, New York, is the latest concern to enter the field of dry battery manufacturing. The company has established headquarters at 70-76 Fulton Street, where it has a well-equipped factory and has already inaugurated a very satisfactory business.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Chicago, reports that it has just completed one of the finest toll boards for the U. S. Telephone Company for use at Toledo, Ohio, that it has ever turned out. The board comprises five sections of three operators' positions each.

THE TRUMBULL ELECTRIC MANUFACTURING COMPANY, Plainville, Conn., has found it necessary on account of largely increasing business to raise its capital stock to $100,000, and will build a four-story brick factory during the present year. It is the intention of the company to make a specialty of panel and switchboard work.

THE PELTON WATER-WHEEL COMPANY, of San Francisco, reports a brisk business in its line, a large number of sales having been made recently to electric power companies operating steam plants; the Pelton wheels sold to these companies are to be used in supplementary stations operated in parallel with the existing steam stations.

THE NATIONAL CARBON COMPANY, Cleveland, Ohio, naturally feels proud of its award from the St. Louis Exposition. The grand prize given the company by the Jury of Awards covers its complete line of carbon products, including Columbia carbons, Columbia batteries, motor and generator brushes, large smelting electrodes, and carbons for electrochemical work.

CHASE-SHAWMUT COMPANY, Newburyport, Mass., announces that the Shawmut soldered rail-bond is now handled in Philadelphia and vicinity by H. F. Sanville & Co., and that the complete Chase-Shawmut line is handled, in their respective districts, by William S. Brown, New York; Thos. G. Grier Company, Chicago; L. F. Mahler Company, St. Louis; Spranley & Reed, New Orleans, and John R. Cole Company, San Francisco.

THE WESTINGHOUSE ELECTRIC & MFG. COMPANY has closed a contract with the United Railways & Electric Company, Baltimore, Md., for a 5000-kw. three-phase alternator to be direct-driven by a steam engine and to operate in parallel with the five 2000-kw. machines which the company recently installed in the Pratt Street station. The big machine will run at 94 r.p.m. and give 13,000 volts at 25 cycles.

THE ELECTRIC CONTROLLER & SUPPLY COMPANY, Cleveland, Ohio, reports the most gratifying success for its new lifting magnet

designed to handle pig iron, small billets, scrap iron or steel, etc. This magnet is adapted to hang on the ordinary hook of a traveling crane, and is simply lowered into the pile of pigs or billets, energized, and lifted, carrying with it as many pieces of the iron as can get into effective contact with it.

CENTRAL ELECTRIC COMPANY, Chicago, announces that notwithstanding the disastrous fire on February 11 which completely destroyed its offices and warehouse, it has not by any means been put out of business. Temporary headquarters have been established at 209 East Jackson Boulevard, and by the time this announcement reaches the eye of the reader the company will doubtless be in position to give prompt attention to all orders.

B. S. BARNARD & COMPANY is the name of a newly incorporated concern with offices at 39-41 Cortlandt Street, New York. The officers of the company are B. S. Barnard, president; W. H. Barnard, vice-president and treasurer; L. Bancroft, secretary, and A. Dunlop, manager of the electrical department. The company will represent the Peerless Electric Company, Warren Electric & Specialty Company, Colonial Fan & Motor Company, Colonial Electric Company, Boston & Sandwich Glass Company and the Hammond Manufacturing Company.

HARRISBURG FOUNDRY & MACHINE WORKS, Harrisburg, Pa., has just issued a reprint in facsimile of an extensive article which was published by *The Engineer*, of London, and describes the Fleming engine exhibited at the recent St. Louis Exposition. The engine was the latest type of four-valve compound and was used at the Exposition in connection with the Intramural Railway. It received a gold medal and diploma, the highest award in its class, from the International Jury.

QUAKER CITY RUBBER COMPANY, Philadelphia, Pa., is receiving constantly the most flattering testimonials to the merits of its "P.P.P." rod packing. Among recent letters of this character is one from the president of a water company in Kentucky who states that after a great deal of trouble with gritty water, during which all sorts of packings were tried his company put in "P.P.P." packing at a time "when the water was at its worst." The result was that the packing lasted four times as long in the unusually gritty water as flax packing did in clear water, and greatly reduced the cutting due to grit.

ALLIS-CHALMERS COMPANY has adopted the policy of having each of its district offices represent the company's entire lines of manufacture. This has involved the establishing of a number of new branch offices, the lines being so extensive and diversified as to necessitate representation in many places where one or two classes of machinery alone would not justify maintaining local headquarters. The existing branch offices have also undergone changes under the new order of things. At St. Louis, a branch office has been established in the Chemical Building under the management of Mr. H. P. Hill, formerly manager of the local Bullock office; the latter has been consolidated with the new office. At Cleveland, the same change has been made, Mr. Franklin Wharton, the former Bullock manager, being now in charge of all interests. At Pittsburg, Mr. H. Wiedeman, who has represented the Allis-Chalmers engines, etc., there for several years, is now in charge of the complete establishment covering all lines. This is also true of Mr. Geo. W. Mattison, in Kansas City. At Buffalo, N. Y., a new office has been established temporarily in the Ellicott Square Building under the management of Mr. Geo. W. Pulver, who was for several years with the Syracuse office of the Westinghouse Electric & Mfg. Company.

CENTRAL STATION NEWS

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

ALABAMA.

SYLACAUGA.—Bonds to the amount of $24,000 have been sold, the proceeds to be used for the construction of an electric light plant and water works.

GOODWATER.—Arthur Salmon has secured a franchise to install an electric light plant in Goodwater, and hopes to have the town lighted by May 1.

BIRMINGHAM.—This year will be marked in the history of the Birmingham Railway, Light & Power Company as one of expansion. Extensive improvements have been planned by the management, which will include important changes at the present power house at an estimated cost of $150,000, $50,000 worth of improvements to the gas system, the erection of a new power house and passenger station at Bessemer and of viaducts over the railroads here, and a large increase in its rolling stock. At the power house mechanical stokers will be installed, besides other devices for the economy of coal and the saving of smoke. It is expected that these extensive changes will consume a year or more.

ARIZONA.

PRESCOTT.—A big electric power and transmission plant is to be established at Parker's Butte, about 75 miles from Prescott, by the Verde Water & Power Company. It is proposed to develop about 20,000 horse-power which will be transmitted to Prescott and other towns of the territory. It is also planned to supply many mines with power.

ARKANSAS.

SILOAM SPRINGS.—The Siloam Springs Railroad, Power & Light Company has been incorporated with a capital of $500,000.

POCAHONTAS.—S. C. Dowell, of Walnut Ridge, states that he expects soon to erect a $25,000 electric plant in this city.

MADILL.—Plans are under discussion for the establishment of an electric light plant here, but nothing definite has been decided as yet.

ENGLAND.—The contract for the erection of the electric light plant for England has been let to the Martin-Reynolds Electric Company, of Little Rock. The plant is to be ready for operation in ninety days and will run at first fourteen street arc lights.

CARLISLE.—An electric light system is to be installed here in the near future, it is said, but no information has been received concerning the details of the enterprise, and whether a local plant is to be established or the current supplied from an outside source is not known at the present writing.

CALIFORNIA.

SAN JOSE.—The National Park Electric Company, with a capital of $250,000, has been incorporated by J. J. Inman, M. E. Page, W. H. Baugh, and others.

SANTA BARBARA.—Articles of incorporation have been filed for the Merchants' Mutual Light & Power Company by John T. Johnston, C. H. Frink and J. H. Burson.

OAKLAND.—Press reports state that an ordinance is to be introduced in the City Council providing for the placing of all wires underground in the business district within the next three years.

EUREKA.—Application has been made by the North Mountain Power Company for a franchise to construct and maintain an electrical transmission line over certain public roads and highways of Humboldt County.

FRESNO.—The San Joaquin Power Company has decided to begin at once the construction of another power plant near the Crane Valley reservoir, with a capacity of 3500 horse-power. William G. Kerckhoff, of Los Angeles, is president of the company.

MARYSVILLE.—The Bay Counties Power Company, which is controlled by the California Gas & Electric Corporation, of San Francisco, is making preparations to erect a new power plant and construct a transmission line along the Yuba River from Smartsville to this city.

SAN FRANCISCO.—The San Mateo Power Company has filed articles of incorporation setting forth its purpose to manufacture gas and electricity for heat, light and power and stating its capital stock to be $1,000,000. Among the directors named are: Walter J. McLean, Henry Bostwick and Leo H. Susman.

LOS ANGELES.—Members of the Broadway Improvement Association have formed a company to establish an independent lighting plant to furnish power for lighting the 135 clusters of arc lights along Broadway. Stock to the amount of $100,000 has been subscribed and preparations are already under way for the establishment of the plant in the shortest possible time. F. W. Blanchard, Maj. J. H. Norton, J. M. Schneider, Avery McCarthy, N. Bonfilio and C. W. Fleming are among those interested in the project.

SAN FRANCISCO.—It is stated that the California Gas & Electric Corporation has purchased the plants of the South Yuba Water Company and the Central California Electric Company. The company has also purchased property across the line in San Mateo County on the bay shore near the Seven-Mile House. It is the intention of the company to put up a plant to furnish electric power to the United Railroads of San Francisco and to other parties as well. It is understood that the engines for the proposed plant have been ordered.

MARYSVILLE.—Plans are being developed for electrical power in Yuba County which may rival the Colgate plant of the Bay Counties Power Company. There has been filed in Yuba County a notice of location of a claim to 100,000 inches of the water of the Yuba River, the same to be diverted at the point near Smartsville known as The Narrows by means of a dam which will about cost $800,000. While the names of James O'Brien, of Smartsville, and J. E. Ebert and Lon H. Mitchell appear in the notice as the locators, it is understood that the capital to further the scheme will be provided by the Marysville & Nevada Power Company. From The Narrows the water is to be conducted by means of a ditch 40 feet wide on the bottom, 80 feet wide on top, and 10 feet deep, along the north bank of the river to a point on the Forbes ranch, thence along the north bank of Dry Creek to the Sicard Flat crossing, where it is to be used for the generation of electric power. Below this point the water is to be again taken up and carried north to Honcut Creek for irrigation purposes. All the surplus water is to be returned to the Yuba River through Dry Creek. In order to secure the stone and timber for the proposed dam at The Narrows the same locators have taken up a tract of land in section 22, naming it "The Narrows Placer Mining Claim."

COLORADO.

RIFLE.—A. L. Hackenberger, of Dallas, Tex., is making arrangements to construct an electric light plant in this city at a probable cost of $25,000.

DENVER.—Improvements which will cost approximately $300,000 are to be made by the Denver Gas & Electric Company, the work to begin at once. A new building will be erected at a cost of $100,000, while other improvements and extensions to the gas mains will aggregate $200,000 more. In proportion to size, Denver now stands second among the light consuming cities of the United States, Grand Rapids, Mich., being ahead of it by virtue of its numerous furniture factories. The increased use of electricity has been a large factor in the growth of the Denver plant.

Eleven factories and lumber mills along the Rio Grande tracks south to First Street have decided to abandon steam motive power for electricity and a new electric transmission line has been completed to Golden for operating dredgers in that section.

GREELEY.—The Greeley Gas & Electric Company has been incorporated with a capital of $50,000, by Charles E. Ramsay, Martin A. Bunker, Burton D. Sanborn and others.

COLORADO SPRINGS.—At the annual meeting of the Colorado Springs Electric Company, held January 31, officers were elected as follows: President, W. A. Otis; first vice-president, George R. Buckman, both of Colorado Springs; second vice-president, S. R. Bertron, of New York City; secretary and treasurer, Irving W. Bonright, Colorado Springs; assistant secretaries and treasurers, F. W. Stehr, of Colorado Springs, and Murray Dodge, of New York City; general manager, George B. Tripp, of Colorado Springs.

CONNECTICUT.

WILLIMANTIC.—The gas plant and the electric station of the Willimantic Gas & Electric Light Company have been thorougly remodelled under the supervision of Arthur E. Jackman, engineer, of Boston, who has been retained as superintendent of the works.

GEORGIA.

ROME.—The City Council will petition the State Legislature for permission to construct and operate a municipal electric light plant.

CAIRO.—The Clerk of Council writes that the citizens have voted to issue $15,000 bonds for the construction of water works and an electric light plant.

AUGUSTA.—Recent advices state that the Augusta-Aiken Railway & Electric Company is installing in its plant a 250-kw. two-phase Bullock alternator.

CONYERS.—W. G. Flake, president of the Panola Light & Power Company, writes that the company contemplates extending its lines to Covington. The extension will cost between $15,000 and $20,000.

IDAHO.

EMMETT.—The electric light plant of J. H. Forbes is to be taken over by a stock company according to local reports.

LEWISTON.—C. A. Weyerhauser, William Deary and others are interested in a project to erect a power plant on the Clear Water River near this city.

ILLINOIS.

CHICAGO.—The Edison Light Company has been incorporated by Clayton R. Taylor and Percy B. Eckhart, with a capital of $2500.

FAIRBURY.—The Fairbury Electric Light & Power Company announces an increase in its capital stock of $18,000, which brings its capitalization up to $30,000.

WAUKEGAN.—A special committee has been appointed to investigate the feasibility of establishing a city electric light plant and to devise means of securing a better water supply.

MONMOUTH.—The Monmouth Gas & Electric Company is preparing plans for various improvements at its plants, among which are included important changes to the electric light plant.

BLUFFS.—Reports state that Henry Knoppel, secretary of the Bluffs Exchange Telephone Company, together with Fred Brockhouse, expects to establish an electric light plant here in the spring.

EAST ST. LOUIS.—The East St. Louis Consumers' Electric Light, Power & Heat Company has been incorporated with a capital stock of $75,000 by H. J. Dehaan, Fred W. Zegenhein and others.

EAST ST. LOUIS.—The St. Clair Light & Power Company has been incorporated for the purpose of furnishing light and power. The capital is $75,000 and C. L. Gray and H. C. Bernard are among the incorporators.

DANVILLE.—The Danville Street Railway & Light Company is about to put in a 1500-h.p. engine and a 60-cycle alternator to supply all of the alternating-current lighting in Danville. Most of the transformers have been changed from 130 to 60-cycle types already.

ELGIN.—At a recent stockholders meeting of the Elgin Hydraulic Company plans were discussed for the formation of a $100,000 concern to establish a hydro-electric power plant. If the project is consummated, an auxiliary steam plant will be installed for service during low-water periods.

DIXON.—The titles to and ownership in the dam and hydraulic plant of the Dixon Power & Lighting Company are said to have been acquired by the Lee County Lighting Company, of which H. C. Higgins is the manager. The consideration in the transaction is stated as $200,000.

AURORA.—A company, known as the Aurora Manufacturing & Lighting Company, has been incorporated for the purpose of engaging in a general manufacturing business and furnishing electricity for light and power. The company is capitalized at $12,000, and Percy G. Lincoln and F. W. Detray are among those interested in the concern.

AURORA.—The Western United Gas & Electric Company has been formally organized in this city with a capital of $5,000,000. This is understood to be a reorganization of the Fox River Light, Heat & Power Company, operating on a capital of $500,000, and it is expected that the new concern will take over and consolidate several large plants.

JERSEYVILLE.—The Jerseyville Illuminating Company, which was recently organized, has decided to take over the plant of the Jerseyville Light, Heat & Power Company which now operates the lighting plant of the city. The members of the selling company are practically the same as the ones comprising the new concern. The illuminating company also decided to erect a hot-water heating plant and will run both a day and night circuit for lighting purposes, and also for furnishing day power. The proposals to increase the capital stock to $100,000 and also to remove the power plant from its present location at Pearl and Lafayette streets to a point near the Chicago, Peoria & St. Louis Railway station were also considered. These will be decided at a later stockholders' meeting in Jerseyville.

LOCKPORT.—Proposals for constructing the power house of the Lockport power development near Lockport, Illinois, on the extension of the Main Drainage Channel of the Sanitary District of Chicago, will be received by the Clerk of the Sanitary District at Room 1110 Security Building, Chicago, Ill., until April 12. The power house is to be a concrete structure about 160 feet wide, 386 feet long and 100 feet in height. It is to contain 9 turbine chambers with bulkheads designed for a working head of 34 feet of water, a generator room 62 feet by 359 feet and offices 20 feet by 62 feet. The work for which bids are invited includes excavating the site, supplying all materials for the sub-structure and superstructure of the power house, and erecting same complete, according to plans and specifications furnished by the Sanitary District of Chicago.

INDIANA.

NOBLESVILLE.—The City Council has granted to the G. W. Heinzman Company, of this city, a franchise for the city lighting.

MUNCIE.—William F. Warner has petitioned the City Council for a franchise to construct and maintain an electric light plant in Muncie.

TERRE HAUTE.—The power plant of the Terre Haute Traction & Power Company was recently destroyed by fire. The amount of the loss has not been ascertained.

FLORA.—At a recent meeting of the Town Council a franchise was granted to David Milles for an electric light plant. The contract calls for 15 arc lights at $80 each per year.

HUNTINGTON.—This city seems to have been very successful in the management of its municipal lighting plant. One hundred and four lamps are in use, and on the basis of cost for the months of September, October, November and December, the cost per lamp per year is $43.14.

SHIRLEY.—Late advices are to the effect that bids will be received about May 1 for the construction of water works and an electric light plant to cost from $15,000 to $25,000. All communications in reference to the matter should be addressed to B. T. Martindale, secretary of the Commercial Club.

IOWA.

SIOUX CITY.—A charter has been granted to Tilden & McRoberts, of Chicago, Ill., for a lighting, heating and power plant. Under the terms of the franchise, $100,000 must be expended within a year.

KEOKUK.—The U. S. Senate has passed a bill authorizing the Keokuk & Hamilton Water Power Company to construct a dam across the Mississippi River from Keokuk to Hamilton, Ill. It is estimated that the cost of the dam, lock and electric power plant that will be installed will be about $5,000,000. The promoters hope to furnish power not only to Keokuk and Hamilton, but to various cities within a radius of 70 to 100 miles. The company is required to build a dam and put in locks sufficient for the present commerce of the river, and to furnish the government drydock facilities. Five years are allowed for the company to begin the work, and it must be completed in ten years.

WATERLOO.—The Peterson Heat, Light & Power Company, of Des Moines, has petitioned for a franchise to install its system in this city, and it is probable that the franchise will be granted. This is the first franchise sought by the company since its organization late last fall. It is a company of Des Moines men organized under a patent secured by Oscar F. Peterson on a system of heating, lighting and ventilating. The officers are: President, Oscar F. Peterson; secretary, Charles H. Baker; treasurer, Sidney A. Foster; members of the advisory board, ex-Governor Frank D. Jackson, Charles H. Austin, W. G. Dumont, J. H. Dusenberry, W. M. Barnes and C. L. Nourse. It is the plan of the company to sell stock to a certain amount in each of the cities where a plant is installed, thus giving a local interest to each plant. Officers of the company say that they expect to make their Waterloo plant a model for other plants which they hope to install in the other cities of the State. The territory east of the Mississippi has been sold to Eastern parties who are now arranging to build municipal plants during the coming summer.

KANSAS.

INMAN.—A lighting franchise has been granted to A. S. Grosvenor by the City Council.

LACROSSE.—The question of issuing $25,000 light and water bonds is reported to be under discussion here.

PITTSBURG.—A franchise to establish an electric light plant is reported to have been granted to Morris Cliggitt.

COFFEYVILLE.—It is stated that the contracts for the equipment of the proposed municipal electric light plant have been awarded.

WAVERLY.—W. H. Williams, City Clerk, writes that Burns & McDonnell, of Kansas City, Mo., are the engineers for the construction of water works and an electric light plant. The work will probably cost $15,000.

KENTUCKY.

COVINGTON.—The City Council has engaged T. J. Creaghead, engineer, to investigate and report upon the cost of the proposed municipal electric light plant.

HARTFORD.—The Kentucky Light & Power Company has in course of construction a new lighting plant, the work being in charge of J. W. Hale, of this city.

CLOVERPORT.—A. L. Fort and Lee E. Cralle, of Louisville, together with several local capitalists, have organized a company to construct water works and an ice and electric plant for Cloverport. The new concern will be known as the Cloverport Water, Light & Ice Company.

LOUISIANA.

VIDALIA.—J. W. Wiggins, manager of the Vidalia Light & Water Company, writes that work has been commenced on the construction of a

water works system and a combined electric light and ice plant. The cost of the work is estimated at $40,000.

ABBEVILLE.—George W. Summers, secretary of the Council, writes that it is proposed to construct water works, an electric light plant and sewerage system. The citizens will shortly vote on the question of issuing $45,000 bonds for the purpose.

PLAQUEMINE.—A charter has been granted to the Plaquemine Electric Light & Power Company, having a capital stock of $30,000. It was organized to install a system of electric lights for the city, with J. H. Savage, M. Dick and V. M. Barber as directors.

SHREVEPORT.—The bursting of a fly-wheel in the electric light plant recently partially wrecked the establishment and left the city in darkness until the damage could be repaired. The present city lighting contract will expire shortly and bids are wanted April 11 for lighting the city for periods of five and ten years. Address C. G. Rives, comptroller.

MAINE.

HOULTON.—The Houlton Electric Light & Power Company has been organized for the purpose of generating and supplying electricity for heating and lighting. The company's capital stock is $10,000 and the incorporators are Hudson T. Frisbie and Walter P. Mansur, of this city.

WATERVILLE.—A petition has been presented to the Legislature to incorporate the Messalonskee Electric Company, by Harvey D. Eaton, Walter S. Wyman, John N. Webber, and others. The purpose of the company is to generate and distribute electricity in this city. Oakland, Fairfield, Benton and Winslow. The capital is stated to be $250,000.

BANGOR.—Recent reports are to the effect that the Maine & New Brunswick Electric Power Company will in the early spring begin the development of its property at Aroostook Falls, and it is understood that before the end of the year the company proposes to have in operation a plant to supply electric light and power to a number of towns in Maine and New Brunswick. Arthur G. Gould, of Presque Isle, is said to be interested in the project.

MARYLAND.

CHESTERTOWN.—Mr. D. S. Pindell, of Saulte Ste. Marie, Mich., who has been granted a franchise for the construction of an electric plant and lighting system, writes that the franchise covers a period of forty years and that work on the plant will commence at once. The cost is estimated at $30,000.

MASSACHUSETTS.

SPRINGFIELD.—The Committee on Public Lighting has given a hearing on the petition of W. S. Kelley to revive the corporate powers and to confirm the acts of the Hoosac Electric Power Company. It is proposed to distribute power to Monroe, Florida, Clarksburg, Williamstown, Adams and North Adams.

MILLIS.—The new electric light system, which has been in course of construction here by the Medfield Electric Light & Power Company, has been completed. Over 125 incandescent lights of 25 candle-power each have been placed in position on the principal streets. The Selectmen have entered into a three years' contract with the company.

SHEFFIELD.—The Sheffield Light & Power Company has been granted a charter, with a capital of $5000 and the following officers: President, Samuel M. Fox; secretary and treasurer, Albert L. Barnes. These officers, with George de P. Fox and W. Taylor Day, of Great Barrington, constitute the board of directors. The company purposes furnishing light and power to the residents of Sheffield, and it is said that about fifty private consumers have been guaranteed already.

DALTON.—Recent reports are to the effect that Z. and W. M. Crane have contracted with the Pelton Water Wheel Company, New York, and the Stanley Electric Manufacturing Company, Pittsfield, Mass., for hydraulic and electric apparatus for a water power plant to be installed at the stone mill in the Renfrew District, to supply electricity to the Dalton Mills and other industries. The plant will probably cost about $75,000.

MICHIGAN.

SAGINAW.—A municipal lighting plant for this city is under discussion by the Council.

GROSSE POINTE FARMS.—The Village Council is considering the installation of an electric light plant.

DE WITT.—Arrangements have been made with the Lansing & Suburban Traction Company to furnish electric lights for the village.

SPRING LAKE.—The West Michigan Light & Power Company has been awarded a three-year contract to supply light to this city.

DOWAGIAC.—D. E. Connine, superintendent of the city electric light plant, writes that the plant will be remodelled at a cost of about $1400.

PONTIAC.—It is said that A. Jacobs, of Detroit, has been here recently, looking over the ground with a view to establishing a gas and electric light plant in the near future.

MARQUETTE.—It has been decided to change the open-arc system, now in use in this city, to the enclosed-arc alternating-current lamp system, and a contract has been awarded to the Westinghouse Electric & Manufacturing Company for 125 alternating-current street lamps, two 75-lamp converters, switchboard panel and other equipment necessary to make the change. The contract amounts to about $3300.

MINNESOTA.

HIBBING.—The Hibbing Water, Light & Power Company has been incorporated by D. D. Crowley, H. A. Liedel and John W. Day to establish a water, light and power plant. The capital is $50,000.

ROYALTON.—Royalton is soon to commence the installation of an electric light plant, it having just floated $10,000 bonds for this purpose. The bonds brought $10,371, with ten bidders in the field.

STILLWATER.—The Stillwater Gas & Electric Company has filed amended articles of incorporation in order to raise money to pay off the old bonded indebtedness, construct a new gas works in Stillwater, and to take over the property of the Apple River Power Company, which latter concern generates electricity for this city.

MISSISSIPPI.

SEMINARY.—The Mason Lumber Company, of Platt Station, has decided to construct an electric light plant, and will furnish lights for Seminary.

LAUREL.—The electric light and power plant of the Laurel Improvement Company was recently destroyed by fire, entailing a loss of $14,000, $8000 of which was covered by insurance. The fire started at the switchboard and is thought to have been due to defective insulation. The city is in darkness and many small industries which were operated by electric power were forced to close down temporarily. The company will rebuild at once on a larger scale.

MISSOURI.

LEXINGTON.—The Lexington Gas & Electric Company has been incorporated.

HARLEM.—The Henry Light, Power & Manufacturing Company has been incorporated at this point.

MADISON.—Local capitalists are agitating a project to operate an electric light plant in connection with the mill.

STURGEON.—The recent special election resulted in the carrying of a proposition to put in an electric light plant.

INDEPENDENCE.—The light plant of this city was shut down the night of February 14 on account of a coal famine.

HIGBEE.—The Higbee Electric Light, Heat & Power Company has authorized W. K. Falmer, of Kansas City, to prepare plans and specifications for and superintend the construction of an electric light plant which it is proposed to establish here.

SEDALIA.—Joseph McWilliams & Co., of Louisville, Ky., have been selected by the Sedalia Water, Gas & Electric Company to prepare plans and specifications for a new central power station and to erect the same, complete with all machinery and apparatus to operate the street railway and waterworks and to furnish current for the city and commercial lighting. The cost of the plant is estimated at about $145,000.

ST. LOUIS.—The sale of the St. Louis syndicate's interest in the Union Electric Light & Power Company and the Laclede Gaslight Company to the North American Company, has been officially confirmed by Julius S. Walsh, president of the Union concern. It is announced that the syndicate got a little less than $3,000,000 worth of North American stock in exchange for its Laclede and Union stock of $6,000,000 par value. The Mississippi Valley Trust Company will act as agent of the North American in taking up the stock sold and issuing the new North American stock to the members of the syndicate. Several of the St. Louis capitalists are to be taken into the North American board of directors.

MONTANA.

NORRIS.—Thomas A. Ferguson writes that work will begin as soon as weather will permit on the construction of a power plant.

FORSYTHE.—The Council has entered into a contract with J. E. Edwards to light the town with electricity for a period of twenty years.

FORT BENTON.—The Benton Electric Light Company has been incorporated at Fort Benton with a capital stock of $15,000. The incorporators are John Harris, W. K. Harbor, Charles Lepley, John V. Carroll, C. H. Evers and L. D. Sharp. The company will build a hydro-electric plant for lighting the town.

NEBRASKA.

EDGAR.—The electric light plant, for which a franchise was recently granted to Keefe & Larkin, has been completed and is in operation.

NEW JERSEY.

HIGHLANDS.—G. W. Hardy, Borough Clerk, writes that it is proposed to construct water works and an electric light plant at a cost of $25,000. No engineer has been selected, however, and the question has not yet been voted upon.

RAHWAY.—At a recent meeting of the stockholders of the Carteret Electric Light, Heat & Power Company, it was decided to sell the stock to the Public Service Corporation. The par value of the stock is $100, and the Public Service Corporation paid $150 for it, giving a bond issue in payment.

LUMBERTON.—George F. Reid, J. M. Harrison, Walter M. Voorhees, Henry Conrow and Moses S. Watson, all of this city, have organized the Lumberton Light, Water & Sewage Company, a corporation with an authorized capital of $50,000, which will be used in the erection of lighting and water plants, and the installation of a sewer system for the town.

METUCHEN.—The Metuchen Gas & Electric Light Company has been organized with a capital of $50,000. The president is Patrick Convery; secretary, Robert Carson; treasurer, John W. Whelan, of Elizabeth; directors, A. F. Rittenmeyer, Patrick Convery, Robert Carson and L. D. Johnson. The new company has begun the work of laying gas mains through Raritan Township, and will erect a plant here at once.

NEW MEXICO.

LAS CRUCES.—The Las Cruces Electric Light & Ice Company has been incorporated with a capital stock of $50,000. Among those interested in the company are Ben L. Berkley, Joseph Wilkinson, of El Paso; Theodore Rouault and Herbert B. Holt, of this city.

NEW YORK.

HOLLY.—Reports state that the Albion Power Company will purchase the municipal electric light plant here, and will in the future furnish the town with electricity for lighting and heating purposes.

CAMDEN.—It is understood that this village has appropriated $40,000 for the construction of a municipal electric light plant.

AUGUSTA.—M. H. Simmons is president of the People's Light & Heat Company, which was recently incorporated with a capital of $300,000.

WATKINS.—The plant of the Watkins Consolidated Gas & Electric Company was burned on February 3. Watkins will be in darkness until a new plant can be erected.

NEW YORK CITY.—The incorporation is reported of the Cremo Light Company, with a capital of $100,000. Luther E. Hartley and J. I. Tilton are among the incorporators.

KIRKLAND.—C. B. Rogers, of Utica, and Joseph Rudd and S. J. Saunders, of Clinton, form the board of directors of the newly-organized College Hill Electric Light Company, having a capital of $5,000.

ALBANY.—The State River Commission has under consideration plans for harnessing Sacandaga, Racquette and Black rivers in the Adirondacks for the generation of electric power. H. A. Van Alstyne, State Engineer, is on the commission.

CANASTOTA.—The business men of this village seem to be in favor of establishing a municipal electric light and power plant, and have appointed a committee, with E. Saltsman as chairman, to obtain specifications, plans and estimates for the required plant.

SARANAC LAKE.—The Saranac Lake Light, Heat & Power Company has transferred its interests to the Paul Smith Hotel Company for $100,000. The plant will be made part of a much larger system, and the Franklin and Union Falls water power systems will be further developed.

CLINTON.—The Franklin Springs Electric Light Company has been incorporated with a capital of $5000 to furnish electricity in this city, Kirkland, New Hartford and Marshall. The directors are: Frederick DeW. Smyth and Delos DeW. Smyth, of Utica, and Edward B. Stanley, of this city.

PALMYRA.—The Palmyra Gas & Electric Light Company has been incorporated with a capital of $25,000. The company will manufacture and distribute gas and electricity for light, heat and power. The directors are named as follows: C. M. Hunt and Charles McLouth, of Palmyra; Charles A. Schwarm, of Hornellsville; George H. Shepard and William T. Morris, of Penn Yan.

ROCHESTER.—The Eastern Monroe Electric Light & Gas Company is an organization recently incorporated with a capital of $250,000, for the purpose of operating in Rochester, Irondequoit and Brighton. The directors of the new company are Henry C. Brewster, A. H. Brown, Walter A. Parce, Clarence E. Shuster. It is stated that the offices of the company will be in Rochester, while the main power plant will be located in Despatch.

TROY.—At an early meeting of the Cohoes Common Council the Hudson River Water Power Company will make application for a franchise, with the privilege of constructing a power line to Cohoes, so that it may furnish electric power to Cohoes manufactories. It is understood that the advent of the company in Cohoes is favorably looked upon by many business men, and it is likely that the company will be granted a franchise when it applies for it.

SYRACUSE.—The report is circulated that the Syracuse Lighting Company, if successful in procuring a renewal of its contract for the city lighting, will expend at once about $100,000 for improvements. The plant will be greatly enlarged, and with the increased capacity, the Lighting Company will be in a position to furnish electricity for the operation of the Syracuse & South Bay Electric Railway, the latter company having decided to purchase its power. New street arc lights will be installed, and any other improvements necessary to render the company's service adequate and complete will be made.

BUFFALO.—The Iroquois Electric Company has filed articles of incorporation, with a capitalization of $1,000,000, for the distribution of electric light, heat and power in this city and vicinity. This concern is understood to be substantially a distributing company for the Ontario Power Company, of Niagara Falls, Ont., and if the franchise asked for is granted, expects to be in position to furnish 30,000 horse-power by the 1st of July. The directors are General Francis V. Greene, Edmund Hayes, William H. Hotchkiss, George K. Birge, William H. Gratwick, R. K. Albright and Stephen M. Clement. Besides Buffalo and the Tonawandas, the company proposes to operate in the towns of Wheatfield, Pendleton and Cambria in Niagara County, the towns of Amherst, Cheektowaga, West Seneca, Clarence and Lancaster in the county of Erie, and also the villages of Lancaster, Depew and Williamsville.

NEW YORK CITY.—Mayor McClellan presented to the Board of Estimate on February 10 plans suggested by Cary T. Hutchinson, George F. Sever and Nelson P. Lewis, the committee recently apponted to consider the matter of establishing a plant for electric lighting the Boroughs of Manhattan and the Bronx. They estimate the total cost of a system capable of serving 6000 arc lamps and 250,000 16-c.p. incandescent lamps at about $4,100,000 exclusive of the cost of real estate; total cost of annual operation is $906,000.

HOLLEY.—Reports state that the Albion Power Company has made a proposition for the purchase of the municipal lighting plant here. The company offers $15,000 for the building, including the real estate, boilers, engines, electrical machinery, poles, lines and distributing system; to be paid by the bonds of the village amounting to $15,000, together with interest on those bonds from date of purchase at 4 per cent. The electric current for light, heat and power will be furnished to private consumers of Holley for a 24-hour service at the same price as it is furnished to the citizens of Albion and Brockport. The streets and public places of the village will be lighted as required, either by arc lamps or incandecent, maintaining the present service of eighty 20-c.p. lamps at $1600 a year. The company asks for a five-year contract and a permanent franchise. It is now furnishing power and light to Waterport, Albion and Brockport.

NORTH CAROLINA.

WASHINGTON.—The incorporation of the Empire Light & Power Company is reported, with a capital of $150,000. D. S. Fletcher and H. A. Smith are among the incorporators.

GRAHAM.—Plans for the new water works and electric light and ice plants for Graham are being prepared by Engineer H. A. Pressey, of Washington, D. C., and bids will probably be called for immediately.

ANDREWS.—The Andrews Light & Power Company has been incorporated, with a capital of $100,000, to construct and maintain a water works system, electric light and power plant and a telephone plant. J. Q. Barker and E. G. Henneman are largely interested in the new project.

OXFORD.—Contracts for constructing the water works and electric light and ice plants have been awarded as follows: Goulds Manufacturing Company, one 800-gal. triplex pump; Reeves Engine Company, a 90-h.p. vertical non-condensing engine; Cole Boiler Company, two 150-h.p. tubular boilers; Westinghouse Electric & Manufacturing Company, electric power station equipment; Chesapeake Construction Company, poles, lines, arc lights, etc., and incandescent light secondary circuits; York Manufacturing Company, 15-ton ice plant; Chicago Bridge & Iron Works, 100,000-gal. water tower; Glamorgan Pipe & Foundry Company, cast-iron pipe, specials and hydrants and valves.

OHIO.

LOVELAND.—The establishment of a lighting plant here is being agitated by the citizens.

CANTON.—Articles of incorporation have been filed by W. L. Davis and W. B. Weber for the Sandy Valley Light, Heat & Power Company.

BOWLING GREEN.—The County Commissioners are reported to have under consideration the construction of a lighting and heating plant.

LORAIN.—The Council has decided to purchase the necessary machinery for the installation of a small lighting plant at the pumping station.

MIAMISBURG.—Bonds to the amount of $19,000 have been sold for the purpose of merging the electric light plant and water works into one plant.

CLEVELAND.—The Cleveland Street Lighting Company was recently incorporated with a capital of $10,000, by Frank M. Gregg, A. F. Hills and others.

MAXVILLE.—Reports state that this city is soon to have a very complete modern electric light plant, but none of the particulars concerning the project have been given out as yet.

LEBANON.—The Miami Transit, Light & Power Company has been incorporated with a capital of $600,000 by F. O. Richards, M. D. Burke and others.

TOLEDO.—The contract for lighting the streets of this city for two years has been awarded to the Toledo Railway & Light Company at $83 per arc light per year.

CLEVELAND.—The National Light & Manufacturing Company has filed articles of incorporation, naming among its directors George L. Chandler, W. B. Matthews and Erwin H. Guthery. The enterprise is capitalized at $25,000.

STEUBENVILLE.—Frank S. King, City Auditor, writes that the council has under consideration the question of submitting to a vote of the people at the spring election the construction of a municipal electric light plant, to cost $180,000.

NORWALK.—Bids will be received until March 21 by the Board of Public Service for furnishing the necessary lights for a period of ten years to properly light the public places, streets, avenues and alleys, with either gas or electric lamps, or a combination of them.

HAMILTON.—The Hamilton Gas Light & Coke Company has changed its name to the Hamilton Gas & Electric Company and increased its capital to $1,000,000. The company will spend at once about $250,000 in improvements and extensions, and expects to install in the near future a new electric power plant.

MARION.—The Marion Railway, Light & Power Company plans to make important improvements in its electric light system during the coming summer, at a cost of $50,000 or $60,000. The entire overhead system will be overhauled to make it uniform. The railway system will also be improved.

SPRINGFIELD.—The interests of the Citizens' Heat, Light & Power Company, which was incorporated something less than two years ago, will be absorbed by the new concern recently incorporated under the name of the People's Heat, Light & Power Company, and capitalized at $1,500,000. John L. Zimmerman is president of the new company, and others interested are: F. M. Hagan, Albert H. Kunkle, W. W. Keifer, Walter L. Weaver, Frank Clark and Frank Torrence. It is stated that contracts will be let immediately for a modern lighting and power station, to be erected on the Jefferson Street site purchased recently. The station is to be 66 feet by 165 feet, and two stories high. It will be made of brick and steel. Unless the company can have a switch laid from the railroad, a chute will be dug from the Panhandle tracks into the basement. It is estimated that the cost of construction and equipment and laying the conduits and pipes will be about $500,000.

OKLAHOMA TERRITORY.

OKEENE.—The Okeene Ice & Light Company has been incorporated with a capital stock of $50,000.

WANETTE.—Philip Hall, of Shawnee, is said to be interested in the construction of water works and an electric light plant here.

KINGFISHER.—The Citizens' Gas Light, Heat & Power Company has been incorporated with $100,000 capital, by E. E. Hull, C. C. Roberts and J. B. Buckles.

STROUD.—A charter has been issued to the Stroud Light & Power Company, having a capital stock of $15,000 and the following stockholders: A. H. Sherwood, Lee Patrick, H. M. Jarrett and G. T. Haines, all of this city, and Sam R. Flores, of Oklahoma City.

ANADRAKO.—The Union Light & Power Company, of El Reno, has been awarded the contract for constructing an electric lighting plant to be operated in connection with the water works. The plant, it is estimated, will cost about $10,455, and is expected to be ready for operation within ninety days.

OREGON.

JACKSONVILLE.—The City Council recently granted A. E. Recunes an electric light franchise, the plant to be in operation in three months.

PRAIRIE CITY.—Dr. Carlton Faull and Alfred Curry, of Baker City, are reported to be negotiating for the purchase of the Prairie City electric light plant. If purchased, about $25,000 will be expended for improvements. They will also construct water works.

PENNSYLVANIA.

COLUMBIA.—John S. Graybill, Jr., of Lancaster, is said to be one of the incorporators of the Columbia Electric Light, Heat & Power Company, which has a capital of $10,000.

BRIDGEPORT.—The Norristown Electric Light Company, of Norristown, is said to have secured the contract for lighting the streets of this village at $70 per lamp per year.

PITTSBURG.—The People's Light & Power Company, recently organized at McKeesport, has been granted a franchise by the Select Council of Pittsburg to erect poles and string wires on all the streets.

HANOVER.—The statement was made in these columns last month that Mr. Mumper had been awarded the contract to light the streets of this borough. We are informed now, however, that Mr. Mumper was unable to produce the required bond of $5000 at the time specified by the Council, and the contract was therefore given to the Hanover Light, Heat & Power Company for the term of five years.

WEST SCRANTON.—An application is to be made to the governor for a charter for the West Scranton Light, Heat & Power Company by William T. Davies, John H. Williams, Herbert L. Taylor and others, all connected with the West Scranton bank. It is understood that the company proposes to operate principally in West Scranton.

YORK.—The papers of incorporation of the Yoe, Windsor and Dallastown Electric Light Companies, which were granted by the State Department at Harrisburg last month, have been filed in the office of Recorder Bentz. The corporations each have a capital stock of $5000, divided into 200 shares. The incorporators and directors are: Eli S. Nisly, Florin, this State; George R. Heisey, Lancaster; E. R. Heisey, Dallastown. The purpose of the companies is to furnish Dallastown, Yoe, Red Lion and the surrounding territories with light, heat and power by means of electricity generated at Red Lion, the companies having secured the old match factory at that place for their plant.

MIDDLEBURG.—George W. Wagenseller, of this city, and David Goldstein, of Pittsburg, have secured a franchise for the construction of a power plant on Middle Creek below Selinsgrove. A company will be organized with a capital stock of $50,000. The proposed site is between two mountains, the location being known as Hoover's dam. It is the company's intention to tunnel the mountain, which will require about 900 feet of excavation, giving a water pressure of about 600 horsepower. When the plant is completed electricity for lighting and power purposes will be furnished within a radius of many miles.

SOUTH CAROLINA.

BRANCHVILLE.—Advices state that bids are now being received for an electric light plant and telephone exchange to cost about $6000.

CLINTON.—Engineer Charles C. Wilson, of Columbia, writes that no date has yet been set for the opening of bids for the proposed water works and electric light plant. It was stated last month that bids would be received February 15.

CALHOUN FALLS.—Dr. S. M. Orr, of Anderson, and O. S. Sheffield, of Atlanta, are interested in developing the Savannah River power above Calhoun Falls, including Cherokee and Gregg Shoals. Joseph E. Sirrine, of Greenville, is said to have prepared the plans. The dam will be 1000 feet long, 24 feet high, and will develop 6600 horse-power.

GREENWOOD.—A. J. Sproles, superintendent of the Greenwood water and electric light plant, writes that they are in the market for quotations on the following apparatus f. o. b. Greenwood, specifications and guarantees to accompany each bid: One 180-kw. revolving field three-phase 60-cycle, 2200-volt alternating-current belted generator; one each 60 and 120-kw. revolving-armature single-phase 60-cycle 2200-volt belted generators; seventy 1200-c.p. series alternating-current arc lamps complete, out-door type; one-half gross clear inner globes extra; 48 clear outer globes extra; one 100-light constant-current transformer with two leads for two circuits, complete with meter and switchboard. Bids are desired on each generator, and the lamp outfits separately and together. No orders will be placed, however, until the Commissioners of Public Works have thoroughly canvassed all specifications, guarantees, prices, etc., in detail, which will probably be the latter part of March.

SOUTH DAKOTA.

DELL RAPIDS.—Recent local reports are to the effect that the question of municipal electric lighting is again under consideration.

MONTROSE.—Mark Donahue and P. G. Williams, of this city, are organizing a company for the purpose of establishing an electric lighting plant.

TENNESSEE.

CAMDEN.—A new electric light plant is to be installed in Camden soon. L. A. Wyatt, backed by local capital, is pushing the project.

JOHNSON CITY.—The Board of Aldermen and the Mayor have petitioned the Legislature for permission to vote and issue $250,000 bonds for the construction of water works or for the purchase of the local system, and $50,000 for the building of an electric light plant.

TEXAS.

UVALDE.—A franchise has been granted for the installation of an electric light and power plant here.

BAIRD.—The Home Telephone & Electric Company has filed articles of incorporation with a capital stock of $25,000.

GONZALES.—The Citizens' Electric Light & Power Company is reported to have doubled its capital stock recently, it amounting now to $10,000.

FORT WORTH.—F. W. Potter has petitioned the City Council for a franchise granting him the privilege of establishing an electric light and power plant.

LUFKIN.—The Lufkin Electric Light & Power Company has been incorporated by S. W. Henderson, G. F. Hackney and J. S. Henderson, and is capitalized at $30,000.

HOUSTON.—Chris L. Nielson, representing Evans, Almirall & Co., of New York City, will be in Houston for the next few months in connection with the work of reconstructing the plant of the Houston Light & Power Company, that work being now in progress.

SAN ANTONIO.—C. A. Zilker, vice-president of the Southern Ice & Cold Storage Company, of this city, is said to be interested in a plan to organize an independent electric lighting company in this city. The plant, if established, will cost probably $100,000, and will be equipped to furnish both light and power.

TEXARKANA.—H. N. Morris, president of the Shreveport Gas, Electric Light & Power Company, Shreveport, La., was here recently promoting a deal whereby the Dawes Syndicate, which owns the above mentioned company, acquires the plant at this place, the transaction involving in the neighborhood of $200,000, it is said. It is the intention of the purchasers to spend considerable money in improving the property. The officers of the Texarkana company are: President, H. N. Morris; vice-president, R. C. Dawes; secretary, J. B. Sherman.

UTAH.

HUNTSVILLE.—The citizens are considering the question of issuing bonds for the construction of a municipal lighting plant.

PARK CITY.—Henry Shields and associates are said to have secured a franchise to furnish electric light and power in this city.

FORT DOUGLAS.—The Utah Light & Railway Company, of Salt Lake City, has secured the contract to furnish current for lighting this post.

VIRGINIA.

MANASSAS.—W. E. Crosen & Co., of Leesburg, are stated to have petitioned the City Council of this city for a franchise to erect and maintain a system of electric lighting for a term of fifteen years. The proposed plant will have a capacity of 750 standard 16-c.p. lamps.

WASHINGTON.

TACOMA.—C. B. Hurley is said to have retired from the Tacoma Gas & Electric Company.

WINONA.—Thomas & McTier are about to establish a light plant to furnish light for this city, Endicott and La Crosse.

SEATTLE.—T. H. Warford, Harry Merritt and B. A. Nelson, all of this city, have incorporated the Sumas Electric Light & Power Company for $30,000 to do a general light and power business.

ELLENSBURG.—Ellensburg is now lighted with electricity from the water-power plant, situated on the river three miles above the town. The new plant has a capacity of 1000 horse-power.

REARDAN.—J. M. McDowell has begun the work of installing the electric plant for which the Reardan council recently granted him a franchise. He expects to have the town lighted very shortly.

GREY'S HARBOR.—Manager J. D. Crary, of the Grey's Harbor Electric Light & Power Company, has recommended purchasing $75,000 worth of new machinery to be used in changing over the electric light plant at Aberdeen, this State.

SEATTLE.—The Council is arranging to place all the companies, corporations and persons doing an electrical business, under the City Electrician, all work to be done in accordance with the National Electric Code.

SEATTLE.—The municipal electric light plant has been placed in operation, and City Comptroller Riplinger is about to ask for bids for $250,000 bonds to be used for the purpose of extending the lighting system to the residence portion of the city.

SEATTLE.—The Diamond Ice Company has extended its lighting circuits as far as its present franchises permit. Plans are under way for enlarging the plant, in anticipation of extending its system as soon as the necessary franchise can be secured.

TACOMA.—Mayor George P. Wright expects ultimately to be in a position to submit to the City Council a proposition whereby the city will own its own electric light plant. Parties are willing to erect and install a plant and take in payment therefor bonds guaranteed by the revenues from the plant.

SPOKANE.—It is rumored that the Spokane Light & Power Company, composed of George Turner, F. P. Hogan, J. C. Williams and others, which has a franchise in Spokane to lay wires for electric lights, heat and power purposes, is preparing to take advantage of its franchise and install a system.

WEST VIRGINIA.

BERKELEY SPRINGS.—The Berkeley Springs Light & Water Company has been incorporated, with a capital of $25,000, for the purpose of establishing water works and an electric light system.

WISCONSIN.

NEW LONDON.—It is expected that the new electric light plant, now in course of construction, will be completed soon.

ONALASKA.—A petition has been filed with the Council by D. L. Aiken and others for a franchise for an electric light plant.

DODGEVILLE.—Frank H. Pavey has recently assumed the management of the Dodgeville Electric Light & Power Company, of this place.

IRON RIVER.—The Iron River Water, Light & Power Company, of which F. F. Macmiller is president and Byron Ripley, secretary, has increased its capital stock from $25,000 to $100,000.

LA CROSSE.—Announcement has been made that the Wisconsin Light & Power Company, which was recently granted a franchise, will erect its plant on the north side, and will probably extend its service to Onalaska.

CANADA.

SHERBROOKE, ONT.—The contract between the city of Sherbrooke and the Sherbrooke Power, Light & Heat Company for lighting the streets having expired, the company has made an offer to the city stating that if a contract for ten years is entered into it will reduce the rate from $60 to $50 per light per year, and give a discount of 10 per cent. on the meter rate.

American Electrician.

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POWER AND LIGHTING EQUIPMENT OF A CALIFORNIA HOTEL

ENGINEERING FEATURES OF "THE POTTER" AT SANTA BARBARA, CAL.

BY C. W. WHITNEY.

At Santa Barbara, Cal., is located The Potter, one of the largest and most up-to-date hotels in the West. Designed to cater largely to the tourist trade, the hotel has been built to provide every comfort and pleasure possible for its guests, and provision for its own utilities has also been made to an interesting extent. The hotel has an independent water supply, which in that district means much, and from its own power station are provided steam heating, hot water, electric lighting, power, refrigerating, and drinking-water services. The engineering details of these installations, as well as other features of mechanical or electrical interest, which have been provided for the safety and convenience of guests and employees, will be brought out in the following description.

The Potter, stands on an elevated tract of land, 30 acres in extent, facing the Pacific Ocean, from whose beach its grounds are separated by a broad city boulevard. The style in which the hotel is built is Spanish Renaissance, arranged with wings so that there are no inside rooms, the views being toward the ocean for some, toward the Santa Ynez Mountains for others, while some rooms have views of both. The structure is frame, with plastered walls, the roof being finished with Spanish tile. Nearly 500 guest rooms are provided, as well as offices, spacious dining halls, loggia, ballroom, kitchens, storerooms, etc. In two

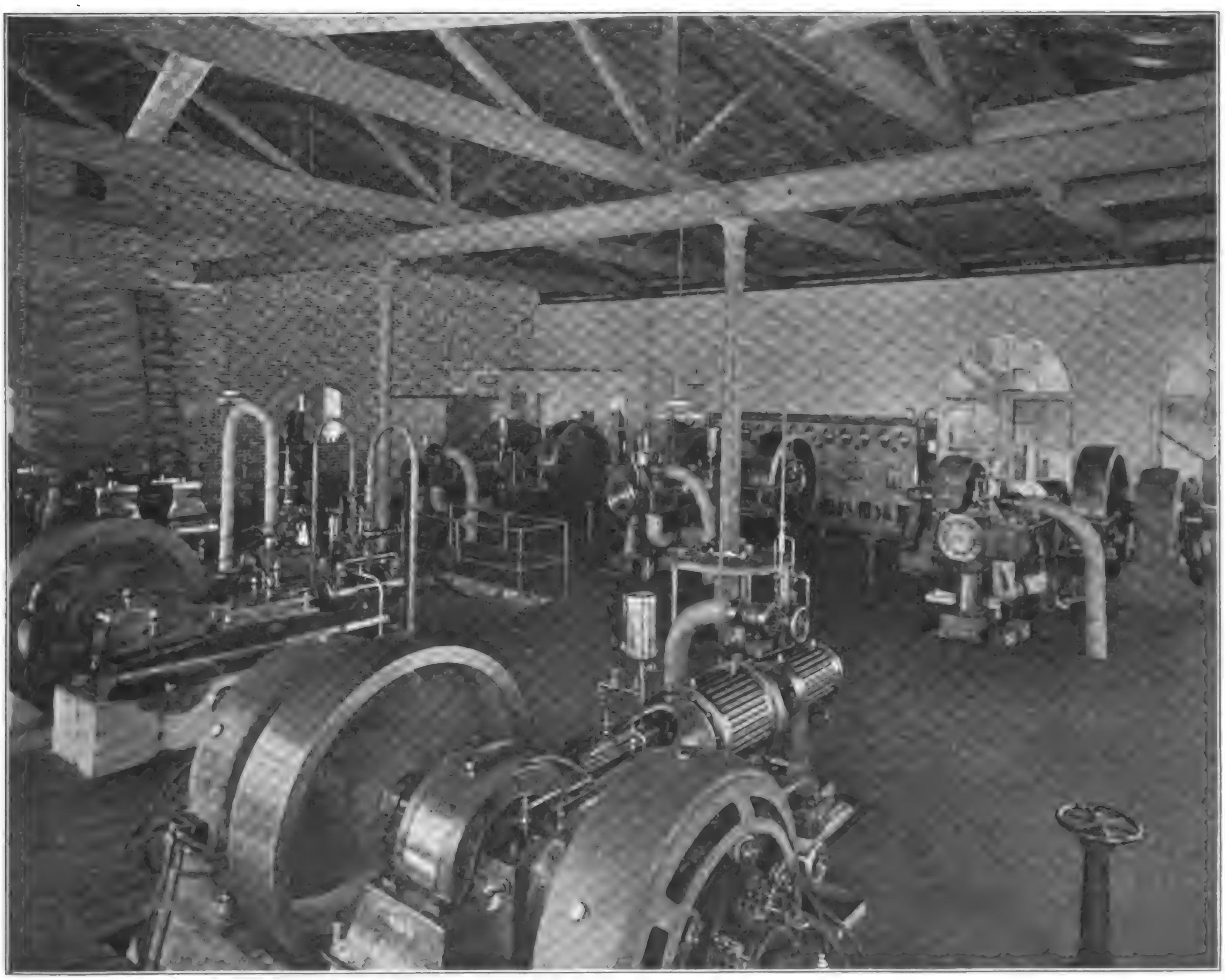

FIG. I.—GENERAL VIEW OF THE ENGINE ROOM OF "THE POTTER."

separate buildings in the rear of the east wing are the laundry and the quarters for the help, while adjoining the former and back of the central wing is the power house. Fig. 2 is a plan view of the boiler and engine rooms, and shows the general arrangement of live steam, exhaust and water piping.

The power house is constructed of brick, the outside being plastered and painted in harmony with the other buildings. The house is divided into a boiler room 56 ft. by 60 ft., and an engine room, 60 ft. square. Adjoining these in the rear is a shop 50 ft. by 30 ft., in one corner of which are located lockers and wash and bathrooms for the station attendants.

In the boiler room there are four Cahall horizontal water-tube boilers, rated at 225 horse-power each. The two 30-in. drums of each boiler are connected to 12 9-tube headers, making a total of 108 4-in. tubes per boiler. Two 11-in. by 15-in. manholes are provided in each drum. The boilers have Reliance water columns with high and low-water alarms, one on each drum. The twelve rear headers are connected to a cast-iron mud-drum, which has three 6-in. by 8-in. handholes, and is provided with two 2½-in. blow-offs, with asbestos stops and Crane angle blow-off valves. These blow-offs are all connected to a 4-in. pipe that leads to a tank 4 ft. in diameter and 12 ft. long. This tank has an 8-in. vent extending through the roof of the boiler room, and a 4-in. drain line to the sewer. There is also a 4-in. by-pass around the blow-off tank that is used in draining dead boilers and in cleaning out.

Each boiler is equipped with two 4-in. pop safety valves, set to blow off at 135 pounds, two 8-in. gate valves with 2-in. by-passes in the main steam line, and one Ashcroft 260-pound steam gauge.

All four boilers are connected to a breeching in the rear, and thence the hot gases are carried to a brick stack, 125 ft. high, built square for 16½ ft., and then round to the top with an inside diameter of 66 in. The top is capped with stone. The stack is lined with firebrick for 50 ft. The walls are 31 in. thick at the base, gradually tapering to 13 in. under the stone cap at the top. They are supported by a massive foundation of concrete, in which iron rails are embedded.

Oil is employed exclusively for fuel for the boilers as well as for the bake ovens, and the kitchen ranges. The oil used runs from 20 to 22 degs. Baume. It is stored in two steel tanks, 30 ft. long and 7 ft. in diameter, located about 200 ft. from the power house. These tanks hold about 205 barrels each. They are placed underground in a pit lined with concrete, for convenience in unloading by gravity from wagons or cars. At present the oil is hauled in wagons, but a spur track is to be installed so that the tank ears ean be taken directly to the storage tanks. Seepage is taken from the concrete pits by means of an ejector which discharges into the sewer system. Each tank is equipped with steam pipes so that the oil can be heated, if necessary, to facilitate its pumping. The fuel oil pumps,

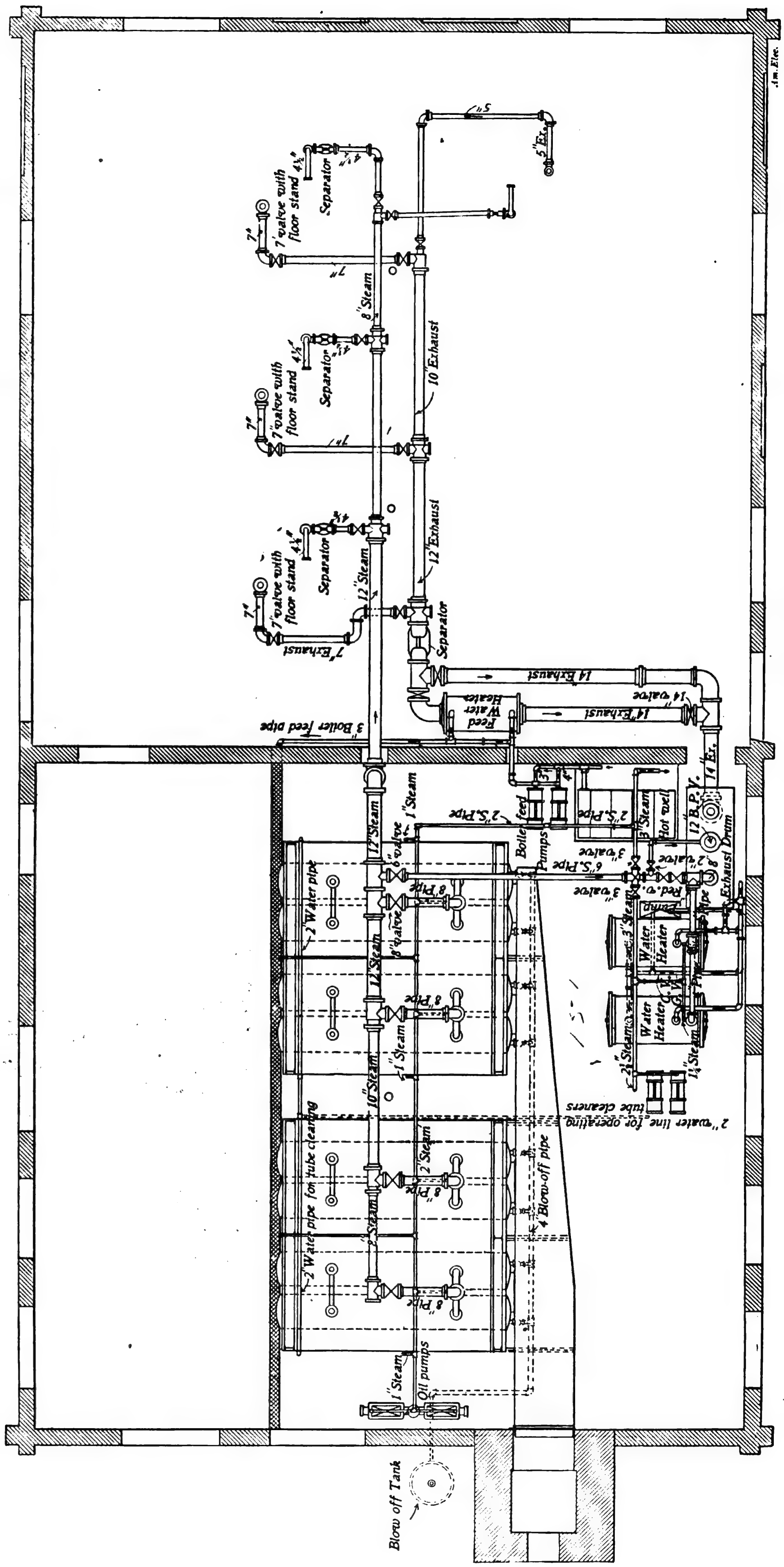

FIG. 2.—PLAN VIEW OF STEAM AND WATER CONNECTIONS.

two in number, are 4½ in. by 2¾ in. by 4 in. in size, of the Worthington duplex type, and are located in front of the boilers. They draw the oil from the tanks and discharge it directly into the burner pipe lines, the surplus being returned to the storage tanks through a relief valve. This system has the advantage of leaving very little oil in the power house at any one time, and that is only what is contained in a small pipe. The oil is atomized by steam in the burners of the bake ovens as well as in those of the boilers. No trouble whatever is experienced with this fuel as long as the burning oil is not thrown directly against the boiler tubes.

The main 12-in. steam line leaves the boilers and drops underneath the engine-room floor, where it branches to the several machines above. Each engine is supplied with an Austin separator, and these are all connected to steam traps that discharge into the hot well. The steam lines were originally suspended from the floor of the engine room, but finding that they caused the floor to sag, the engineer placed all the steam and exhaust lines on stands made of 2-in. pipe. These stands rest on the concrete floor of the basement, and are constructed so as to allow for expansion in the mains.

For boiler-feed purposes, there are installed at the side of the boilers two 7½ in. by 5 in. by 6 in. Worthington outside-packed duplex pumps. These pumps are connected through a 600-h.p. National feed-water heater to the hot well that is located in the rear of the boilers. This hot well is 6 ft. wide and 10 ft. long. It receives the condensation from the steam traps on the engine exhausts, from the hot-water heaters, the steam heating system and the steam auxiliaries.

Fresh feed-water is drawn from two 7000-gallon wooden tanks located over the fuel-oil storage tanks. As the water contains considerable mineral matter it has to be softened before it can be used in the boilers, and the treating is done in these tanks, water being drawn from one while that in the other is settling. F. G. Churchill, the chief engineer of the hotel, experienced considerable trouble from the men letting these tanks run over, so he installed the indicating system illustrated in the diagram, Fig. 5, to give warning at the power house when the tanks are full or empty. Two red lamps are placed in the engine room, each being connected in a three-wire circuit leading to one of the tanks. By means of a float the circuit is closed directly through the lamp when the tank is full, thus giving the lamp full candle-power. When the tank is empty the float closes the circuit through an auxiliary resistance lamp in series with the indicating lamp, thus giving the latter a dim light.

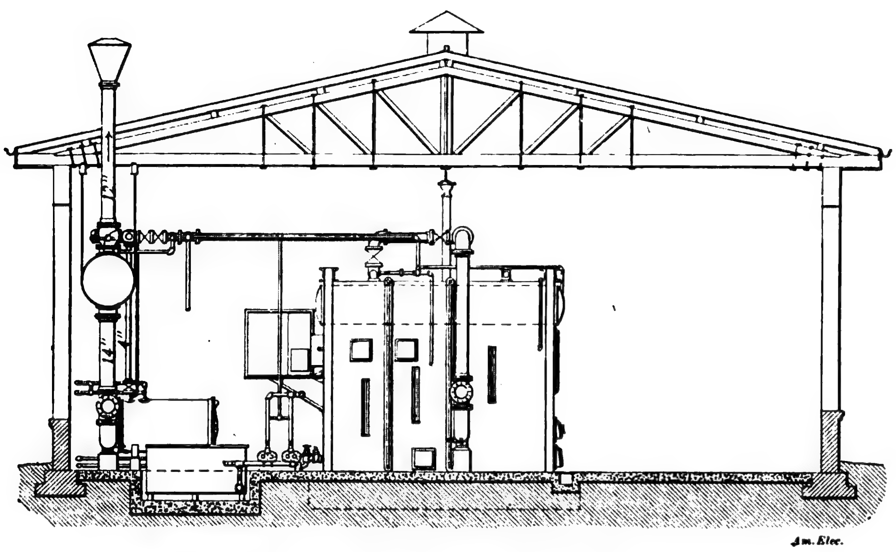

FIG. 3.—ELEVATION OF BOILER ROOM.

Next to the hot well in the boiler room is a 4 in. by 6 in. by 4 in. Moore deep-well pump, which is used to pump all the drainage from the power house to the sewer. An 8 in. by 8 in. by 12 in. Marsh air-compressor is used to lift water from two water wells. In the rear of the boilers are three hot-water heaters used to heat water for the entire hotel. The water is pumped through the hotel by means of a 5¼ in. by 3½ in. by 5 in. Worthington duplex hot-water circulating pump.. For house service there are installed two 6 in. by 4 in. by 6 in. Worthington duplex, and two 6 in. by 7½ in. by 6 in. Blake duplex low-service pumps. These four are used for pumping water for house and irrigation purposes, and also for boiler washing and for pumping water over the ammonia condenser. A 2-in. steam line is taken from each boiler to serve the boiler feed pumps, and, if necessary, it can be used to furnish steam to all of the pumps in the boiler room.

The basement of the engine room is on a level with the boiler room, and besides the heavy concrete foundations of the engines above, it contains the steam and exhaust piping and several auxiliaries. The ammonia condenser for the refrigerator system is installed here, and also a 4½ in. by 2¾ in. by 4 in. Worthington duplex pump, which pumps the water used on the ice machine to the irrigating system. For service in connection with the oiling of the machinery on the floor above, there are in the basement an oil filter and a 2 in. by 1¼ in. by 2¾ in. Blake duplex oil pump. The laundry, kitchen and steam separator traps are also located in this basement, as well as the surge tank, 10 ft. long, 6 ft. wide and 5 ft. deep, which receives the discharge water

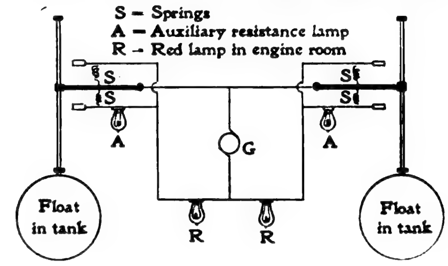

FIG. 5.—INDICATING SYSTEM FOR WATER TANKS.

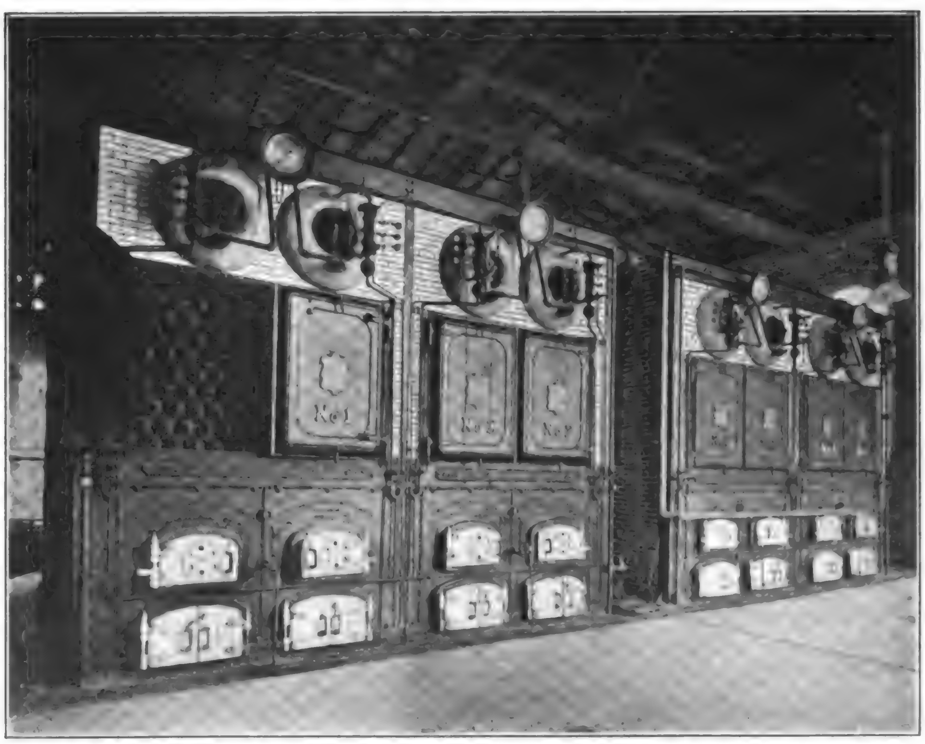

FIG. 4.—BOILER ROOM IN "THE POTTER."

from the hydraulic elevators. The necessary reducing valves on the steam mains leading to the laundry and kitchens, and to the ice machines are also in the basement. Connecting the boiler room and engine room basement with the basement of the hotel building is a large tunnel through which all pipes and wires are carried.

The engine room floor is 8 ft. above that of the boiler room. In this room are located four electric generating sets, one 10 in. by 16 in. Atlas slide-valve engine direct-connected to a 13-ton Barber ammonia compressor and two 12 in. by 18 in. by 10 in. by 12 in. Buffalo compound duplex elevator pumps, as well as the switchboard for the light and power service. On the wall near the elevator pumps are the air pumps used in connection with the elevator system. Two of the generating units consist of 11 in. by 18 in. by 14 in. tandem-compound engines, each direct connected to a 100-kw. 125-volt direct-current generator. The third set comprises a tandem-compound of the same size, direct connected to two 50-kw. 125-volt generators. The fourth engine is a 9 in. by 14 in. by 11 in. tandem-compound, and is direct-connected to two 25-kw. 125-volt machines. The three large engines run at 250 r.p.m., and the small one at 275 revolutions. The engines were furnished by the Ball & Wood Company, New York, and the generators, as well as the switchboard equipment, were furnished by the General Electric Company. Near the ceiling of the engine room is placed a 60-gallon tank for the engine-oiling system. Oil flows from this tank by gravity through pipe lines to the engine bearings from which it drains into a settling tank in the basement. From there the oil passes through a Cross oil-filter into a 60-gallon tank and is then pumped back to the upper tank to be used over again.

Under the kitchen there are provided some 20 cold storage rooms, with 30,000 cubic feet devoted to refrigeration, for fruits, vegetables, meats, fish, poultry, eggs, butter, wines, etc. All of these rooms, except those for poultry and fish, are cooled by the circulation of brine, a 6 in. by 4 in. by 6 in. Deane, of Holyoke, duplex brine pump being used to maintain the circulation. In an ice room is a large brine tank, also served by this pump, for the manufacture of ice for the house use. The fish and poultry storage rooms require lower temperature than is afforded by the brine, so they are cooled by the direct expansion of ammonia, the compressor being located in the engine room as already stated.

To furnish all the water needed for the hotel and its many departments, to irrigate the 30 acres or more of lawn and flower gardens about the hotel during the long dry season, and to afford adequate fire protection, requires a reliable and ample water supply. This is obtained from three sources, viz., the city mains, Mr. Gates' private water works and wells on the hotel grounds. For storage purposes there are provided three large wooden tanks. Two of these have a capacity of 45,000 gallons each, and are built up 24 ft. above ground. They receive water from the Gates private water works, half a mile distant, the pumps being electrically driven by power transmitted from the hotel power house. This water is fed by gravity to the softening tanks for boiler use, and is also pumped throughout the hotel for general purposes. The third tank has a capacity of 30,000 gallons, and is 40 ft. above ground. Its water is pumped from the hotel wells and is used almost exclusively for irrigation. The towers of all three tanks are built of Oregon pine, and rest on concrete piers. The tanks are built of 16-ft. redwood staves, and are covered with conical-shaped shingled roofs.

The water from the city mains is delivered to the hotel at a pressure of 140 pounds. It is used principally for the fire system to which it is at all times connected. The fire system comprises stand pipes, to which are connected 4000 ft. of 2½ in. hose and 3000 ft. of 1½-in. hose. In case of fire almost all parts of the building can be reached without having to stop to connect up any hose. There are also numerous fire-extinguishers distributed about the hotel. . As a further precaution there is a fire department organized among the employees, which is called out by a whistle on the power house roof, a code of signals being used to indicate the part of the house where assistance is needed.

There are several new wells to be drilled on the grounds and a new reservoir of 100,000 or 200,000 gallons capacity is to be added. The elevator pumps are to be connected so that they can pump water directly from the reservoirs to the fire lines, and means will be provided for filling the reservoirs from four different sources, thus assuring plenty of water in case of fire. Especial care is used to furnish pure drinking water, an elaborate filtering and condensing system being installed for that purpose.

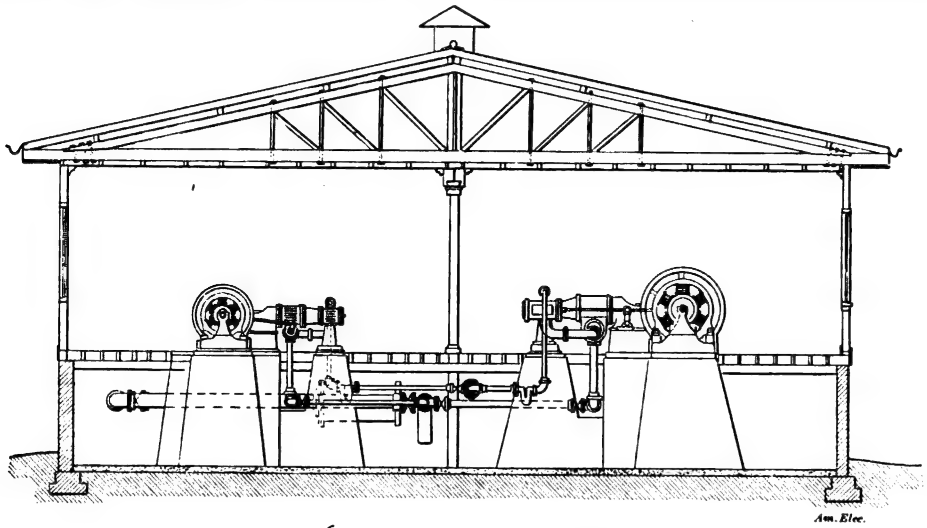

FIG. 6.—ELEVATION OF ENGINE ROOM.

There are seven hydraulic elevators in the hotel. The two passenger and one freight elevators are geared 8 to 1, a waiters' elevator is geared 6 to 1, and a linen elevator has a gear ratio of 10 to 1. All five of these serve six floors. In the kitchen wing are a storeroom lift and a butcher's lift, each serving two floors. For operating the elevators water is delivered from the large pumps in the power house into a large compression tank under 125 pounds pressure. The water then passes to the cylinders of the elevators and thence back to the surge tank, thus making it possible to use the same water over again. Considerable trouble was experienced at first with the water, as corrosion would set in wherever there was any wrought iron or steel exposed to the water. This difficulty has been met by using the drainage from the exhaust separator instead of fresh water in the entire elevator system. This has not only stopped corrosion, but the engineer has also found that there is not required one-fourth the packing that was formerly necessary in the pumps or rams on the entire elevator system.

The light and power service of the hotel is operated on the Edison three-wire system, the lamps taking the single voltage at 110 volts and the motors running on 220 volts. The generators are all compound wound, and so connected that any of them may be run together or they may be cut in on either side of the three-wire system. The switchboard which controls the generators is made of six panels, one for each machine, the equipment of each panel consisting of Thomson astatic ammeter and voltmeter, three-pole, double-throw generator switch, circuit-breaker and Thomson recording wattmeter. There are no feeder panels, the rubber-covered wires being taken directly from ⅜ in. by 3 in. copper bus-bars at the rear of the board, down into the basement and thence to the main building through the pipe tunnel. There are 11 No. 0000 circuits, three of No. 000, two of No. 1, and three of No. 4 wire. In the basement the circuits are distributed to the various pipe wells, which run up through the building, and from these wells are carried to tablet boards of various sizes in the different halls and corridors. These tablet boards are built of white marble and are mounted behind glass doors. Each controls a section of the building and contains a main knife switch, hall light switches, switches for cutting out certain groups of rooms, and the necessary fuses. The wires are carried on porcelain knobs and through circular loom, porcelain tubes being used for holes in joists. All joints are soldered and well taped. The hall lights are all con-

nected to magnetic switches, which are operated by batteries. These switches can be turned on or off at the respective tablet boards, or they can all be handled from a set of push buttons in the main office. The large number of group lights in the general office, loggia and adjoining rooms are handled from a marble panel in the office equipped with 155 knife switches.

In all there are about 12,000 incandescent lamps installed in the hotel and adjoining buildings. Most of these are of 16 candle-power, some 8 and some 4 candle-power lamps being used for decorative purposes.

For exterior illumination along the walks and drives about the grounds some 20 multiple arc lamps are installed. They are of the Adams-Bagnall 110-volt enclosed type. These arcs are controlled from a small switchboard equipped with eight switches and located in the engine room.

The electric motor equipment is installed principally in the hotel laundry and in the kitchen. In the former, which adjoins the power house, there are 20 hands employed, and the most modern machinery is provided. Here all the hotel washing is done, as well as bundle work for the guests. The machinery is run by one 15-h.p. and one 7½-h.p. 220-volt Westinghouse motor.

The kitchen is likewise fitted up with the most modern utensils, the equipment including two large ranges, two broilers, four stock kettles, three steam tables, seven dish warmers, two coffee urns, one hot water urn, and 12 automatic egg-boilers. Two dish washers, a bread crumbler and a knife polisher are run by a 5-h.p. 220-volt Crocker-Wheeler motor. In connection with the kitchen are pastry and bake ovens heated by fuel oil, and six cold storage boxes cooled by brine circulation. Underneath the kitchen and connected with it by the hydraulic lifts already mentioned are the butcher shop and storerooms. Two dumb-waiters are also used to carry supplies from the latter to the kitchen. In the basement are an ice-cream freezer, an ice crusher, a Puritas water pump and a coffee grinder driven by a 5-h.p. Crocker-Wheeler motor. In the vegetable room is a machine for shelling green peas, which does very good and rapid work. It is driven by a 1-h.p. Westinghouse motor. All the flooring in the kitchen and store department is of concrete and is connected to numerous drains, so that water can be used freely in keeping it in a condition of cleanliness.

Electric motors are used in the shop to drive a 22-in. Barnes drill press, a 17-in. lathe and two emery wheels. The shop also is provided with a 2½-in. to 4-in. hand pipe machine and a Buffalo portable forge.

A 220-volt circuit is carried to the Gates water works to furnish current for a 30-h.p. and a 10-h.p. General Electric motor used in driving the pumps. Compressed air is piped to all the generators and to most of the motors for use in blowing dust out of them.

The normal summer load on the electric generating equipment is from 600 to 700 amperes, while during the winter months the load runs up to 1400 or 1600 amperes. The heaviest load that has been carried was one of about 1800 amperes.

A private telephone exchange is installed in the hotel, with about 500 instruments connected. The telephones are of the De Veau type and use 11 volts on the talking and 22 volts on the ringing circuits. In addition to the central exchange telephones, there are six maids' instruments which are switchless, being operated by the user.

In each room in the hotel there is a thermostatic device which operates an annunciator in the office when the room gets beyond a certain temperature, thus affording a safeguard against fire, as well as excessive heat from the heating system.

A system of 40 fire gongs is installed to wake the occupants in case of fire. The gongs are furnished with current at 30 volts from batteries, and are operated from a switch in the office.

The Potter is under the efficient management of Milo M. Potter. F. G. Churchill, chief engineer of The Potter, has had entire charge of the hotel plant for about two years, and has during that time brought the equipment up to a high grade of efficiency, introducing many labor-saving and economical appliances and methods. Acknowledgment is due Mr. Churchill for the data contained in this article and for many of the illustrations.

SOME METHODS OF INCREASING CENTRAL STATION BUSINESS.

BY HOWARD S. KNOWLTON.

Within the past three or four years central station managers have become greatly interested in methods of securing new business, and the results which have followed the efforts of many companies to increase their output have been highly gratifying. In the early days of central station work the rapid development of equipment and well-nigh revolutionary changes in power plant design occurring at that period gave central station managers little time to campaign for new business along the lines practiced so successfully to-day. The capacity of a plant was soon reached, for the mammoth generating units of these times were not in existence, and in some cases there was found a limit to the expansion of equipment through the addition of many small machines. New business steadily increased, but there was not that aggressive enterprise along systematic lines of advertising and demonstration which is now employed in the more progressive organizations.

A study of central station work in different parts of the country, however, shows that many plants operating to-day are by no means doing all the business possible with their equipment. There is room for the exercise of a great deal of practical energy in increasing the output. In the hope of suggesting something useful from the best practice of to-day, the writer has undertaken to discuss the question of increasing central station business, not with the expectation of introducing novel or original methods, but with the idea of emphasizing the innumerable ways in which companies now operating have attempted to reach the public.

To describe in detail the devices which a modern central station is prepared to furnish with current would require nothing short of an encyclopædia. It would take one through practically the entire range of applied electricity, touching upon almost every modern industry, before the ground could be covered. Even if it were possible to prepare a list of all the devices of civilized life depending in some vital principle of their operation upon electricity, the list would scarcely remain complete for a single day. But these resources of the central station are as yet far from appreciated by the general public. It is the opportunity of the central station man, therefore, to bring to the public mind as many of these opportunities as possible, without unreasonable expense. Without saying, the key to the problem lies in the single word—advertise. The sales engineer is needed in the central station no less than in the district office of the manufacturing company.

From an operating standpoint the advantages of increased output are many, especially if the demand can be distributed through a large part of the day, when in most plants a large percentage of the equipment stands idle. As was ably pointed out by Mr. A. W. Zahm in a paper read some months ago before the Iowa Electrical Association, current sold during this period of idleness is a very profitable class of business, and for this reason, especially low rates can often be quoted on certain classes of lighting and other uses of current, without discrimination of an unfair nature against other customers. The point to be kept in mind is the reduction of the ratio of the maximum output to the average. Mr. Zahm divides the field for increasing the output into four different classes—general illumination, power, decorative or advertising lighting, and heating. Among those entitled to specially low rates he includes churches, opera houses and similar public gathering places, since these require a large quantity of current for a comparatively short period at a time when the station peak has dropped off; merchants who have been induced to keep their windows lighted until 11 or 12 p. m. for advertising purposes; electric sign lessees or owners; manufacturers, hospitals, hotels and other customers requiring heat for special purposes during the hours when the lighting load is low; and miscellaneous power users. It is not the object of this article to enter into the question of rates, important as a reduction or modification in them is, in its effect upon the station output. Rate problems must almost always be solved for the particular central station concerned, and although the rates in many plants resemble those in many others, it is important to base them upon the specific conditions locally prevailing, rather than upon what is being accomplished in other localities. Mr. Zahm's paper included a number of general recommendations as to rates which may be looked up by those interested.

One of the most interesting illustrations of central station advertising to be found in practice is the exhibit of the Edison

Electric Illuminating Company, of Boston, on Head Place. Several years ago this company had an attractive exhibit of electrical appliances at the Mechanic's Fair in Boston, and the display proved so popular that it was decided to make the exhibit one of the permanent features of the company's practice. Quarters at Head Place were, therefore, fitted up with improved types of lamps, motors and related machinery, and from this small beginning the exhibit has grown to remarkable proportions. It now occupies two rooms, which are practically filled with apparatus in workable condition, besides an office for the manager of the publicity department, and a storeroom. The attractions of the place have been extensively advertised in the newspapers, street cars and elsewhere, the public being admitted without charge to what is really an up-to-date exposition of central station current consuming devices. Pamphlets describing the equipment are distributed freely. There are comfortable seats for visitors, and attendants are constantly on hand to explain the equipment to interested parties. The company also publishes a small monthly journal called *Edison Light*, which serves to keep its customers in touch with its progress. This is also given away to visitors, and there is a large mailing list of persons to whom the company regularly sends it.

As might be expected, the exhibit is annually visited by many persons, not only from Boston, but from the New England States at large. There are numerous photographs of the company's power plants and sub-stations, representative load curves, etc., mounted upon the walls, and two large books of photographs showing the stages of construction which the larger plants have undergone. In common with other central stations, the Boston Edison Company has no use for the isolated plant, and one of the booklets given away shows photographs, and presents some of the principal details of about a dozen isolated plants in the vicinity of Boston which have been displaced within the past year or two by the Edison service. The booklet further points out the limited capacity of isolated plants in comparison with central station service.

The exhibits are classified under the following six heads: Electrical advertising, domestic appliances, electrical distribution, electric lighting, manufacturing and liberal arts, and electric power and ventilation. During the summer and fall the rooms were kept open from 9 a. m. to 10 p. m., but at present the closing hour is between 5 and 6. The exhibition of electric signs comprises many different forms, from simple sign letters to automatic flashing combinations, and from changeable signs to miniature lamp signs. Under domestic appliances are included a prepayment meter, heating pads, reading lamps, adjustable fans, electric stoves, tea kettle, chafing dish, water heater, flat iron, sterilizer, coffee pot, oven, broilers, foot warmers, soldering irons, stewpans, immersion heaters, curling iron, griddle, plate warmer, and other devices. The distribution exhibit covers meters, cables, wall boxes, switchboards and similar equipment.

The electric lighting exhibit includes various types of arc lamps, theatre dimmers, lamp replacers, adjusters and cleaners, turndown lamps, shades, brackets, adjusters and other fittings.

As one would expect, the greatest variety of equipment is shown under the heads of manufacturing and power. There is almost no limit to the appliances which could be shown under this classification, if space permitted. The entire range of electric motor operation would be but a part of the equipment required to make a complete industrial exhibit. As it is, the Boston Edison Company here has in operative condition an electric forge, which in a few seconds heats a rod of iron up to the welding point, motor driven saws, coffee and spice mills, drills, ice crusher, compressors, ice cream freezers, organ blowers, chopper, carriage call, elevator, sewing machine, pumps, marine sets for lighting and power, glue pot, cigar lighter, lathes, hoist, massage machines, milk shakers, candy puller, laundry machinery, blowers, carpet cleaners, a refrigerating machine, automobile batteries, cold-air regenerator and other apparatus.

There are many practical suggestions to the central station man in the folders and pamphlets given away to the visitors at Head Place. Some of these are published by the makers of equipment, others by the Edison Company itself. The manager, who runs his eye over these publications, is almost certain to find the advantages of different methods of using electricity succinctly stated for the public's benefit, which is exactly what he is likely to be interested in, in his own commercial territory. Thus, the circulars describing electric heating apparatus emphasize the flexibility of the equipment, its convenience, concentration of heat exactly where it is needed, and only while it is needed; the elimination of smoke, soot, poisonous gases, and danger of explosion common to other kinds of heating like alcohol lamps. The cost may or may not be a serious question, after these problems are determined. The quickness with which water may be electrically heated in the nursery and sick room, in hotels when traveling, in the parlor for afternoon tea, etc. are also emphasized. The convenience of electric flat irons, saving of time and wasted heat by their use, and the advantages of many other forms of heaters, are duly described.

One of the pamphlets discusses the problem of motor-driven sewing machines; another describes single-phase alternating 60-cycle motors from 1 to 15 horse-power in self-starting types; and another explains the procedure of the company with regard to inspection from the Boston wire department when new installations are projected. Still another publication of the company records the story of an electric automobile run from Boston to New York and return, with a map of the route and list of charging stations. Automobiles can, in fact, be charged at Head Place. The efforts of the Edison Company to establish charging stations in the entire suburban territory around Boston from Newburyport on the north to South Framingham on the west and Brockton on the south have been largely responsible for the recent increase in the number of electric automobiles used in eastern Massachusetts. Inasmuch as every alternating central station in the country uses direct current in the excitation of its generator fields, there ought not to be the slightest difficulty in charging electric automobiles at such plants, even though a resistance may have to be used for cutting down the current. It means little if central stations here and there offer charging facilities, as the radius of action is limited, with electric automobiles. Every town having a central station ought to have its charging facilities advertised at a few prominent points on the highway by neat signs, directing the chauffeur to the plant and giving the hours during which it is open for business.

One of the best of the Edison Company's publications is a small pamphlet setting forth the advantages of electric arc lights as contrasted with gas lamps. This pamphlet, entitled "Daylight at Night," points out in terse and positive language the vital features of the arc light. It briefly describes the factors which are taken into account when the company's experts make a plan for lighting a place, emphasizing the fact that considering the number of cubic feet adequately lighted the arc lamp is actually superior to candles, kerosene or gas, at less cost of operation. Following this is a brief statement of the theory of light waves, with curves showing the close relation of the arc light to the sunlight and the discrepancy between the latter and gas illumination. The pamphlet closes with a short discussion of the physiological effect of inferior lights and the relative distribution of illumination from gas lamps and enclosed arcs.

Another company which has introduced many modern ideas in the way of gaining new business is the Denver Gas and Electric Company. At the main office on Seventeenth Street, is a comfortable waiting room for the use of the public where nuerous appliances are on exhibition, pamphlets laid out for distribution, etc. A demonstration hall forms part of the building, where lectures can be given for public enlightenment. An interesting exhibit in the waiting room is an electric meter mounted on a small switchboard and connected with various snap switches and lamps of different candle-power, so that anyone who desires can watch its action under different loads. A pithy explanation is printed below the meter, for the benefit of the public. This company keeps in close touch with its customers and frequently sends them folders or other printed matter emphasizing this or that apparatus as suited to their needs. Not long before the writer left Denver the company mailed its customers a neat postal card pointing out the advantages of numbered porch lights for residences, giving the cost of the service per evening, and touching upon the inconvenience which attaches to efforts to

find house numbers on dark streets—an experience with which everyone is personally familiar. The company also published a neat booklet giving a partial list of the uses of gas and electricity in various industries from assaying to wood working.

Small companies, of course, cannot usually afford to adopt the extensive schemes above outlined, in all their details, for securing new business. But it would certainly appear that something can be done, even if it is nothing more than allowing customers and others to visit the station under suitable circumstances, and see the latest "wrinkles" offered for use by the manufacturers. It costs the company little to make such exhibits on its premises, as the manufacturer is usually glad to have this opportunity to display his apparatus. It costs the manufacturer little more than the fixed charges on his equipment as displayed. It is indeed a small and financially straitened central station which cannot afford to spend a little money in the way of advertising its business. Sometimes the daily press can be utilized to good advantage through short advertisements of new equipment or especially desirable apparatus of longer standing. The central station which can afford newspaper advertising might well follow the example of a prominent furniture house in Boston which advertises a single piece with consummate skill every few days, changing the card from time to time instead of inserting a single permanent advertisement.

Finally, it must be borne in mind that central station output cannot be greatly increased by advertising alone. After the prospective customer's attention and interest have been awakened, it remains to complete the transaction by giving him in succinct form the figures and facts which apply to his particular case. This may in some companies be performed by the advertising department, but in others, the services of many different men may be required to close the deal. The engineering department may be called upon to give the results of tests upon similar equipment to that proposed, or the auditing department may be needed to establish the cost of operation of a certain installation. The larger the company the more specialized will be its division of labor, and the results will be felt in securing new business. Central stations have made tremendous progress of late in acquiring motor loads, but the field is still open for progressive development, and will remain so as long as there is a chance for competition in the supply of power and light. Scientific illumination is still to be attained in many quarters, and the future undoubtedly holds radical improvements in store in reference to the production and distribution of artificial light. Time was when the central station and the general public had little in common, but the conditions are changed to-day. Insignificant as the addition of a few lamps or motors may seem in proportion to the total output of a modern urban central station, it is the aggregate of these units which makes up the total connected load, and which helps to make the business profitable.

MODERN ARC LAMPS

BY JOHN HOWATT.

The general supposition that arc lamp development has been practically at a standstill for many years is an erroneous one. It was true of arc lamps some eight or ten year ago, but now each succeeding year shows some development and improvement over the year before. No radical changes are made, of course, nor can there be while the present principles of arc lamp design are retained. Any changes that have occurred have been in the details of manufacture and operation of the lamp.

The recent attention to arc lamp design is due to old lamps having so many faults and giving such poor satisfaction in operation that central station managers and others demanded improvements. All other forms of electrical machinery and appliances had been developed, but the arc lamp was far behind.

The ideal arc lamp for general illuminating purposes must embody the following requisites:

(1) The lamp must be economical. This is of prime importance; for if the cost of operation be prohibitive, all other virtues fail.

(2) The lamp should start rapidly and silently as soon as switched into circuit.

(3) When once thrown into service, it should continue to operate without fail, giving a steady, even light.

(4) The lamp should give a light properly distributed, which can be borne by the eye without discomfort.

(5) The lamp should be shadowless.

(6) The lamp should automatically cut out of circuit when out of order, without affecting any other lamps in the circuit.

(7) The lamp should be compact.

(8) The initial cost, cost of maintenance and cost of repairs should not be excessive.

The first requisite demands something which cannot materially be altered; fortunately the economy of lighting by arc lamps compares favorably with any other method. The second is accomplished by a proper arrangement of solenoids, clutch and dashpot. The third calls for a mechanism for feeding the carbons evenly and a globe for protecting the arc from the wind. The fourth is obtained by a proper use of diffusing globes and reflectors. The fifth can be obtained only approximately; it calls for a lamp with the fewest possible parts below the arc, and these parts, the smallest consistent with strength and rigidity. The sixth requirement calls for a reliable automatic switch; this is of more importance, of course, in series lamps than in constant-potential lamps. The seventh requisite demands that all parts of the lamp be brought together as closely as possible; above all, the lamp should not be long, but this is a fault which has been only partially overcome within the last few years. The eighth calls for several things; the lamp must be made out of some reasonably cheap yet acceptable material which the manufacturer can make duplicate parts of at low cost. For low cost of daily maintenance, the carbon consumption should be low, and the lamp should be so designed that the trimmer can recarbon the lamp in the least possible time. For low cost of repairs, the mechanism of the lamp must be strong and composed of few parts, and the insulation must be good so that the liability of burnouts is reduced to a minimum.

These are the specifications for an ideal arc lamp which have been before the manufacturers since the arc lamp was first introduced, and to design a lamp to meet these requirements has been their aim. But up to about ten years ago the generating end of the system claimed all the attention of the designers and engineers. The arc lamps themselves, where the power was utilized, remained practically the same as when first introduced. And these old lamps certainly left much to be desired, for they did not fulfill any of the requirements of the ideal lamp. They were made up of a complex mechanism of wheels, levers and sliding contacts always getting out of order; they fed very irregularly, and they were by no means compact, some of them being over 60 inches long. When the arc lamps manufactured by the leading electrical companies to-day are compared with those of ten years ago, it will be seen how great arc-lamp development has been.

Among the changes and improvements which have been made in arc lamps within the last ten years, the following may be mentioned: First and most important is the introduction and adoption of the enclosed arc. The enclosed arc has done more than anything else to favor the adoption of arc lamps for general illuminating purposes. It allows a higher potential across the arc, thus making the lamp more economical to use on a 110-volt lighting circuit. The carbon consumption being slow, the feeding mechanism can be simplified, thereby reducing the liability of the lamp getting out of order. In fact, any arc lamp discussion at the present time need only consider the enclosed type of lamp.

Another improvement has been in the length of the lamp, which has been shortened materially; whereas the old lamps were 60 inches long, modern arc lamps are often less than 36 inches long. This has been accomplished by disposing of the lamp rod and having the feed clutch work directly on the carbon rod. This, of course, calls for a good even grade of carbon rod, but the many advantages gained more than compensate for the small added cost of carbons.

In the third place, the lamp design has been made much more simple. It is a strange fact that new designs and inventions are nearly always complicated. Simplicity of construction is obtained only after a process of elimination covering a period of many years. The demand for apparatus which is composed of the fewest parts con-

sistent with proper operation has never been as great as it is at present. This is because simplicity is considered by many to stand for reliability. Arc lamps having long since passed the experimental stage, have now

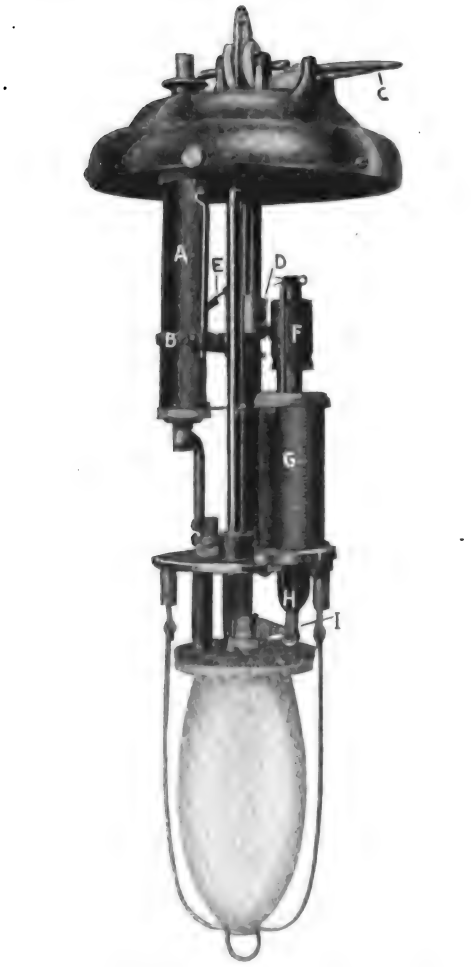

FIG. 1.—GENERAL ELECTRIC DIRECT-CURRENT CONSTANT-POTENTIAL ARC LAMP.

undergone the elimination process, resulting in a lamp with as few parts as it is possible for it to have and operate properly.

Another one of the problems which has been solved within this time is the proper design of an arc lamp for alternating cur-

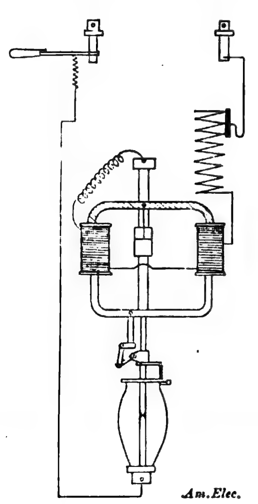

FIG. 1-A.—DIAGRAM OF CONNECTIONS OF GENERAL ELECTRIC ARC LAMP.

rents. The great flexibility of the alternating-current system has caused its general adoption all over the country. To meet this condition it became necessary to design a lamp suitable for operating on alternating-current circuits. The constant-potential alternating-current lamp had been brought out long before this, but it was not a success. It had a low power-factor and made altogether too much noise when operating to come into public favor. Indeed, any alternating-current arc lamp must be very carefully designed to avoid rattling and humming, due to the reversals of magnetism in the reactance coil and the solenoids. That this humming of arc lamps has been successfully overcome is shown by the fact that so many of these lamps are now used for lighting large interiors, such as depart-

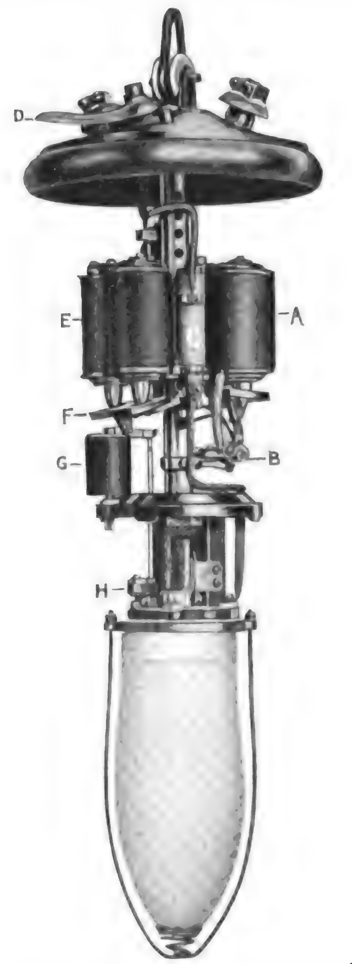

FIG. 2.—JANDUS DIRECT-CURRENT SERIES ARC LAMP.

ment stores and halls, where a noisy lamp would not be allowed to remain.

The series alternating-current arc lamp was not brought out until the advent of the series or constant-current transformer. With a constant-current transformer, such as is manufactured by several of the leading electrical companies, the series alternating-current lamp seems to be one of the best means for street lighting in view at the present time. The transformer regulates closely—more closely than the old direct-current series dynamo—and it is, of course, much more efficient.

There are in use at the present time five distinct types of arc lamps. They are:

1. Series direct-current.
2. Series alternating-current.
3. Multiple direct-current, 110 volts.
4. Multiple direct-current, 220 volts.
5. Multiple alternating-current, 110 volts.

Of these, the series direct-current is the oldest and is now perhaps the least used; for street lighting the series alternating-current lamp will doubtless entirely supplant it. In the constant-potential lamps, 110-volt lamps are more common than 220-volt lamps, although the latter have a great many advocates, especially in the Middle West. The constant-potential alternating-current lamp, used on a high-voltage system in connection with a small transformer, is a rather expensive and cumbersome arrangement and cannot survive.

The accompanying engravings illustrate the different types of arc lamps as they are manufactured and supplied to the trade today. An inspection of them will show how near they come to what an arc lamp should be.

Fig. 1 illustrates a style of direct-current constant-potential lamp for 110-volt circuits, made by the General Electric Company. The lamp embodies several distinctive features in its design, chief among which being the method of winding the magnet coils and the resistance spool. The series magnet coils *G* are wound of bare flat wire on edge and insulated by a non-combustible insulating material. The resistance coil *A* is wound of high-resistance wire in a similar manner. The great advantage of this form of coil construction is

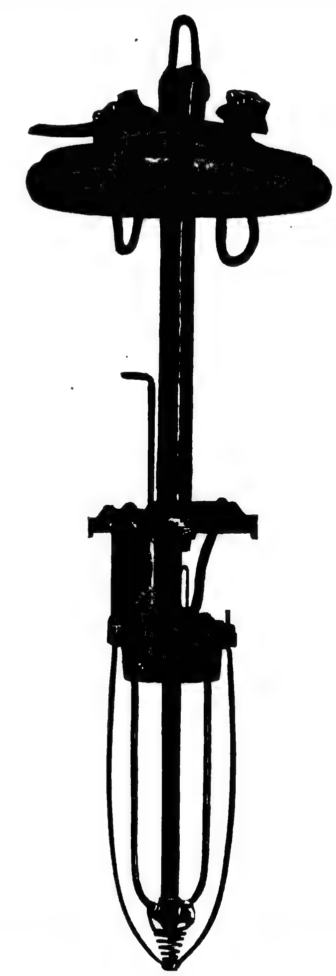

FIG. 2-A.—COMMON FRAMEWORK OF JANDUS ARC LAMPS.

evident to any who have had arc lamps under their care. The ordinary cotton-insulated coils burn out quite frequently, throwing the lamp out of commission. The insulation of these coils cannot burn out.

The main frame of this lamp consists of two steel rods firmly fixed to the upper and lower castings. As the frame of the lamp carries no current, the necessity of insulating these rods from the base is avoided. A dash-pot F steadies the motion of the feeding mechanism. The magnet armature and carbon clutch are shown at H and I. As may be seen, the lamp is of the carbon-feed type, the current being led from the magnet coils to the carbon rod by a flexible connection E. Current adjustment is effected by placing lead washers on the upper carbon holder, as shown at D. Voltage regulation is obtained by varying the resistance of A by means of the sliding clamp, B. C is a hand switch for cutting out the lamp for trimming. Altogether, this lamp embodies many good features.

Fig. 2 shows the lamp manufactured by the Jandus Electric Company for series direct-current circuits. The most noticeable feature of the design of these lamps is the adaptability of one lamp to any service. All the arc lamps made by this company have one common framework shown in Fig. 2-A. A lamp for any desired voltage, for either alternating or direct current, is then obtained by slipping into place on this frame the proper coils and magnets. For central

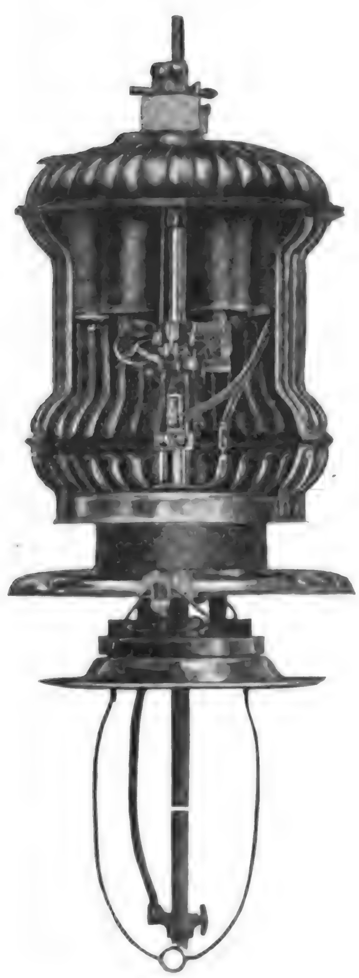

FIG. 3.—WESTINGHOUSE SERIES ALTERNATING-CURRENT ARC LAMP.

stations having a mixed service, both direct and alternating current at 110 or 220 volts, this lamp is especially valuable. The cost of keeping the lamps in repair is materially reduced, owing to the lamps being all of one general style and made of interchangeable parts. This lamp has four magnet coils with pointed poles, two series magnets shown at E and two shunt magnets shown at A. The frame is of the central-tube type

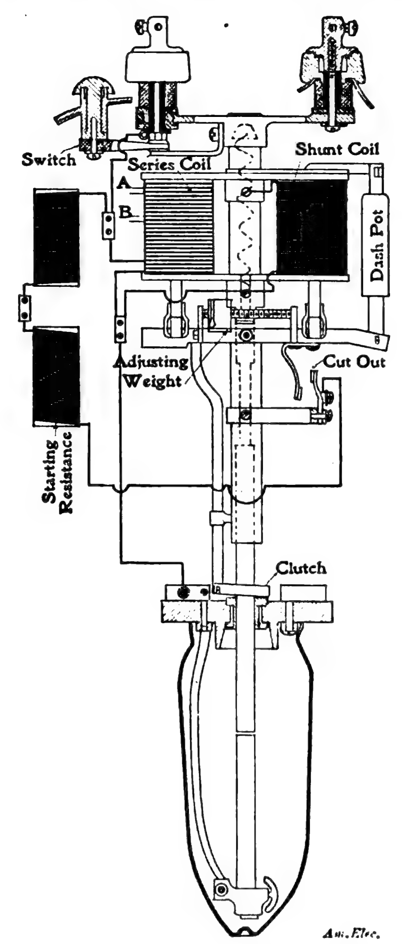

FIG. 3-A.—DIAGRAM OF CONNECTIONS OF WESTINGHOUSE LAMP.

and is of simple and rigid construction. At B is the automatic cut-out with silver contact surfaces. Silver is used in the cut-out because silver oxide, formed by the action of air or the spark on opening the circuit, is still a good conductor, while an oxide of iron, brass or copper has insulating properties. D is the hand switch; F, the perforated armature which operates the carbon rod clutch, H; G is the steadying dash-pot, and C, the resistance in series with the magnets E. It will be seen at once that this lamp is composed of more parts than the multiple type; this is true of all series lamps. In spite of its rather complicated design, this lamp gives good service and is very popular with central station men.

Fig. 3 shows the series alternating-current arc lamp manufactured by the Westinghouse Electric & Manufacturing Company. Fig. 3-A is a diagram of connections for this same lamp. It is seen at once that in a general way the series alternating-current lamp very closely resembles the series direct-current lamp. This lamp operates with 72 volts at the arc and takes normally 6.6 amperes. The series and shunt magnets operate differentially on one rocker-arm which regulates the feed. These magnets are wound on spools moulded from a single piece of vulcabeston. This material has been selected because it has been found to be superior to others for alternating-current work, its use avoiding eddy-current losses and preventing the chattering of the core. The starting resistance is wound on two porcelain tubes placed on opposite sides of the lamp so as not to localize heating effects. In the diagrammatic sketch they are both shown on the same side. The lamp is provided with the two cut-outs usual in all series lamps, one hand cut-out and one automatic. The latter has but one rubbing contact, made of a piece of coin silver fastened with a silver rivet. So close is the adjustment of the lamp that if the potential across the arc increase but five volts above the normal the lamp will be automatically cut out. Current regulation is obtained by shifting the adjusting weight toward the series or shunt coil, according to whether more or less current is desired. The case is made of pressed copper, corrugated for greater rigidity. All the working parts are kept well away from the heat of the arc and arranged so that they can be easily removed and inspected. The insulation of these lamps must necessarily be good. Vulcabeston is used wherever possible instead of porcelain and mica. Each lamp is given a 7000-volt ground test before leaving

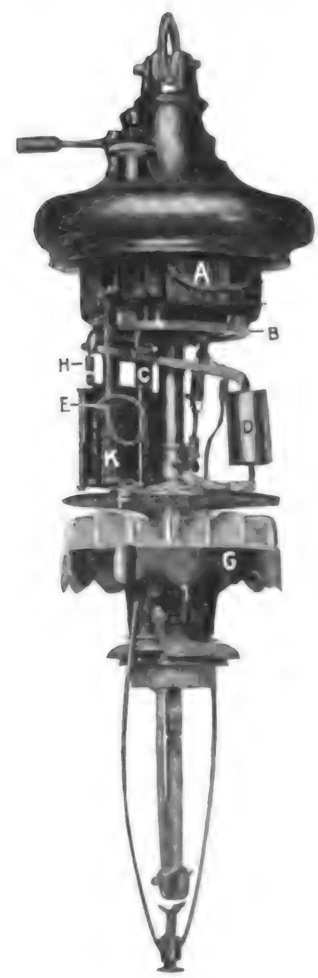

FIG. 4.—FT. WAYNE CONSTANT-POTENTIAL ALTERNATING-CURRENT ARC LAMP.

the factory, so that any insulation imperfections will show up there.

Fig. 4 shows the constant-potential alternating-current arc lamp manufactured by the Fort Wayne Electric Works. These

lamps are designed with especial regard to avoiding vibrations set up by alternating currents. The frame of the lamp consists of a brass central tube inside of which the

FIG. 4-A.—FT. WAYNE REACTANCE COIL.

carbon rod slips. This tube is firmly fixed to a brass casting at the top and bottom. In this style of lamp there is no resistance in series with the arc as the reactance coil, *A*, takes the place of all resistance. Fig. 4-A shows the reactance coil removed from the

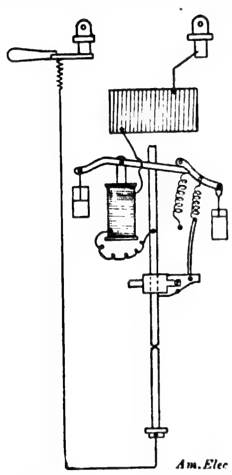

FIG. 4-B.—DIAGRAM OF CONNECTIONS OF FT. WAYNE LAMP.

lamp with core and coil assembled. The reluctance of the magnetic circuit is increased by introducing a fibre strip in the core.

In order to allow for the adjustment of the lamp for various voltages, eight taps are brought out as shown at *T*. This gives a means of adjusting the lamp so that it will operate on any voltage from 100 to 120. The reactance coil is firmly held in place in the lamp by the brass plate *B*. The series solenoids are of double cotton-

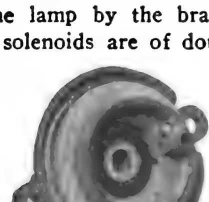

FIG. 4-C.—FT. WAYNE GAS CAP.

covered wire wound on turned fibre spools and are suspended from the bottom of the reactance coil by an oil-tempered spiral spring. The inside of the spool has a German silver bushing to reduce the friction of the armature. The armature, shown at *C*, is of the inverted "U" type, built up of laminated steel punchings held together with German silver rivets. German silver is used because of its high resistance, cutting down the eddy-current losses. The pull of the solenoids on this armature is opposed by an oil-tempered spiral spring. By varying the tension of this spring, the current adjustment is obtained. *D* shows one of the dash-pots, there being one on each end of the armature lever. *H* shows one of the springs introduced to break up any vibration that might arise in the lamp. As a further precaution against vibration, besides all suspensions being by springs, the reactance coil has a felt packing between it and the brass castings, as also have the dash-pot cotter pins. These precautions, while they complicate the design very much, are essential in this type of arc lamp.

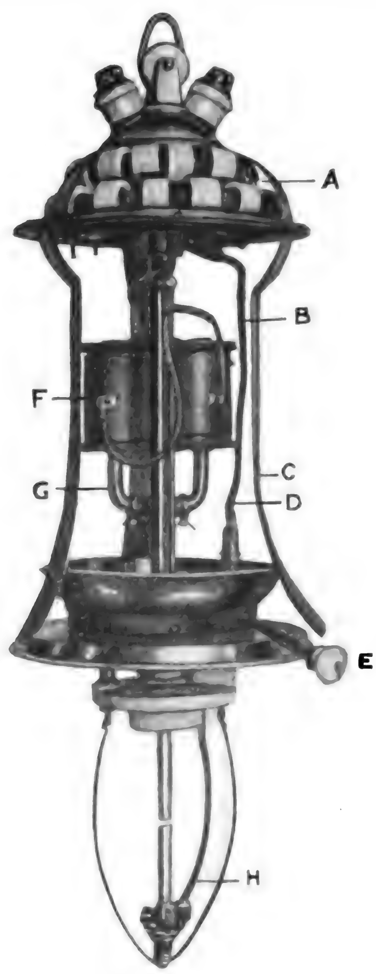

FIG. 5.—ADAMS-BAGNALL DIRECT-CURRENT MULTIPLE ARC LAMP.

G shows a radiator which is intended to keep the mechanism chamber cool. It is made of cast iron, copper-plated, with projecting vanes to present a large radiating surface.

The 220-volt direct-current multiple arc lamp manufactured by the Adams-Bagnall Company, is illustrated in Fig. 5. A comparison of this lamp with the company's 110-volt direct-current lamp shows them to be very similar. The main differences are found in the resistance in series with the arc and the adjustment of the feed mechanism for the different lengths of arc. The simplicity and compactness of this lamp are evident from the illustration. It is of the double solenoid carbon-feed type and is of very rigid construction. In the illustration the resistance is shown at *A*. It is wound in a spiral form, insulated from the lamp frame by porcelain rings. Its location above all the working parts of the lamp insures

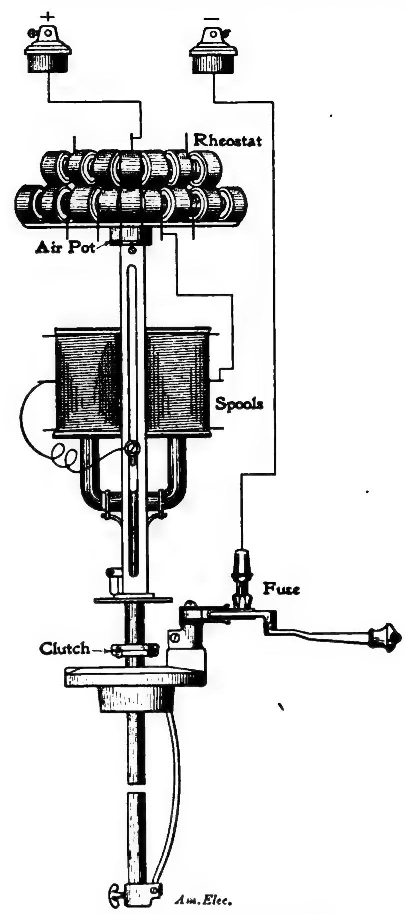

FIG. 5-A.—DIAGRAM OF CONNECTIONS OF THE ADAMS-BAGNALL LAMP.

coolness of the mechanism chamber. Flexible conductors, one of which is shown at *B*, are used throughout the lamp. *C* shows one of the straps used for holding the case in position. The case itself is made of stamped copper, corrugated to increase the rigidity. A door in the case enables the working parts of the lamp to be exposed readily. The series magnets are shown at *F* and the "U" armature at *G*. The extreme simplicity of the armature and clutch is well shown in the illustration. There is but one rod, *H*, for the negative carbon holder. This avoids one of the strong shadows ordinarily cast by arc lamps. The lamp can be adapted to any voltage from 220 to 250 by varying the resistance, *A*. On a 220-volt circuit the lamp takes 150 volts at the arc and a current of 2.5 to 3 amperes. Thus there is no greater loss in the resistance coil than with 110-volt lamps. On account of the higher voltage, the lamp must be designed throughout with greater care as to its insulation. A thorough insulation test in the factory shows any possible weakness in this respect.

The lamps described include all the modern general types and may be considered each as typical of its class. There are a great many other makes of lamps, of course, but these are sufficient to show what the arc lamp developments of the past ten years have produced up to the present time.

THE ARRANGEMENT OF STEAM PIPES.

BY R. T. STROHM.

One of the most noticeable effects of heat is expansion, this being a law which has few exceptions. An ordinary steam pipe, when erected, has about the same temperature as the surrounding atmosphere. Upon admitting steam, however, heat is absorbed by the metal of the pipe and its attachments, which results in increasing their temperature; and this rise in temperature produces expansion of the pipe in all directions.

The rate of expansion is usually expressed as a certain number of parts of the original length, and is called the coefficient of expansion. For cast-iron, wrought iron and steel the coefficients of expansion are as follows:

Cast-iron	.00000617
Wrought-iron	.00000686
Steel	.00000599

Thus, a piece of wrought iron pipe 10 feet long expands $10 \times .0000686 = .0000686$ foot for every degree Fahrenheit increase in temperature. Or, if a steel pipe 300 feet long is heated from 62° to 362° Fahrenheit, the increase in length is $.00000599 \times 300 \times (362 - 62) = .54$ foot or about 6½ inches.

It will be evident, from the foregoing, that when long, straight lines of steam piping are put up, it is absolutely necessary to make some provision for the expansion which will occur as soon as the pipe is subjected to steam pressure. Failure to make proper allowance is certain to be followed by serious consequences. The pipe or some of its fittings may be broken, or the supporting walls split or pushed out by the great force exerted by the expanding pipe.

It is useless to attempt to anchor the pipe rigidly, to prevent this movement. The forces set up by the heat are too great to be thus resisted. To illustrate the magnitude of these forces, a case may be cited in which a steel chimney was badly damaged by expansion. The chimney led up through an office building of some twenty stories. When the stack was put into use it expanded both laterally and longitudinally. The lateral expansion, near the top, caused it to engage with some beams which formed a part of the structural work of the building. The opposite ends of the chimney thus became practically immovable. Consequently, as the longitudinal expansion took place, the rivets in the girth seam of one of the sections were sheared off and the stack simply telescoped.

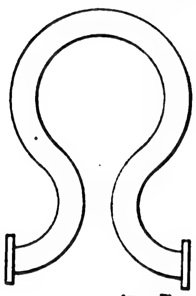

FIG. 1.

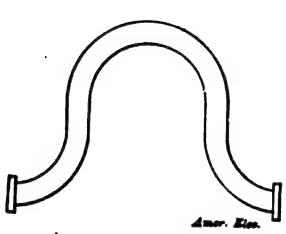

FIG. 2.

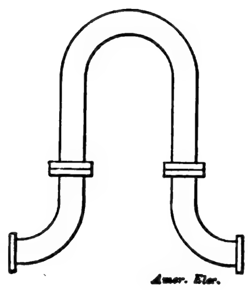

FIG. 3.

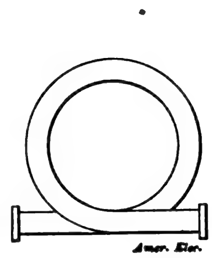

FIG. 4.

There were 48 rivets in the seam, each rivet being ¾ of an inch in diameter. The shearing area of one rivet being .442 square inch, and the shearing strength being taken at 50,000 pounds per square inch, it is plain that a force of more than 1,000,000 pounds must have been exerted, due to the expansion by heat. Of course, steam pipe temperatures are not to be compared with chimney temperatures, but the instance given will serve to show what enormous forces are generated in an expanding pipe.

There are many ways of allowing for steam pipe expansion, but they may be divided into two general classes. First, by arrangement of the pipe in such a manner as to have the movement taken up by the natural elasticity of the material; and, second, by the use of expansion joints.

One method of providing for expansion and contraction is to use a section of pipe bent into the shape shown in Fig. 1, usually termed a gooseneck. It is installed on a straight pipe line. The elasticity of the portion forming the bends is sufficient to take up a considerable amount of longitudinal movement on the part of the straight sections, without seriously straining the bends. The form of bend shown in Fig. 2 is similar to the foregoing, but does not permit the same amount of movement. That illustrated in Fig. 3, formed of two elbows and an inverted U, is open to the objection that the stresses set up, when its lower ends are pushed together, tend to strain the flange joints and are liable to produce leakage on that account.

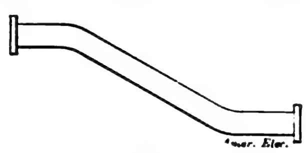

FIG. 5.

In case it is not absolutely necessary to have the whole main in one straight line, the expansion may be taken up by the form of bend shown in Fig. 4, which is a single complete turn of the pipe. In this case the sections connected by the bend will lie parallel to each other but at a distance from each other somewhat greater than the outside diameter of the pipe. In places where the sections may be separated by still greater distances, the bend shown in Fig. 5 may be used. It is not nearly as flexible as the previous forms, but may be used to advantage where the amount of expansion is comparatively small; or, if so desired, a number of these bends may be installed, to take up considerable expansion.

In using the bends shown, care must be taken in order to prevent traps being formed where water may collect, due to condensation in the pipe. If the bend is placed so that its axis lies in a horizontal plane, or if it lies so that its axis follows the slope of the pipe line, then there will be no pockets formed. But it is not always possible to place the bend in such positions. Owing to limited space, it may be necessary to place it in a vertical plane, with the loop either above or below the center line of the main pipe. When this is done, it is necessary to use automatic traps by which the pockets in the bends may be kept free from water.

Unless this precaution is taken, water hammer will result, with its dangers to the plant equipment and to the attendants. It is evident that if a plug of water is caught up and carried along with a steam current traveling at the rate of a mile a minute, serious damage is liable to result when the incompressible volume of water strikes an elbow or a valve in the pipe. For the same reason the pipe should have a gradual slope downward in the direction of flow of the steam current, so that there may be no counter-current of water of condensation to oppose the flow of steam. Exception to this rule may be taken when the pipe is quite large for the work it has to do, in which case the velocity of the steam current will be low.

A form of expansion joint which is used to some extent is shown in Fig. 6. It consists of a section of corrugated pipe, usually made of copper, inserted in the pipe line. Its action, under the effects of contraction and expansion, is similar to that of the old-time accordion. Owing to the large number of corrugations included in a short length of pipe, this form is capable of taking up considerable expansion.

In many instances, these bends have been put into the pipe line in such a way as to be in tension when the line is cold. That is, they are stretched somewhat, to make their flanges meet those of the pipe sections. As the steam is turned on, and expansion of the line occurs, the tension gradually grows less, until a point is reached at which the bend is under no stress at all, as far as expansion is concerned. As the expansion continues, the stresses are reversed, and the bend is compressed. Thus, it is possible to arrange the bends so that the stresses will be divided equally on opposite sides of the normal state.

The types thus far noted take up all

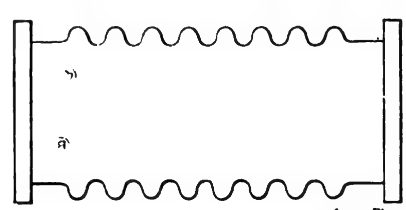

FIG. 6.

movement by their natural elasticity. A second class of expansion joints, however, lack this property entirely, and employ a slip joint, by means of which one section of the pipe slides into another after the manner of a telescope. Such a joint is il-

lustrated in Fig. 7. It consists of a cast-iron section, *A*, enlarged at the end so as to form a stuffing box, *B*, through which extends the pipe, *C*, which forms a portion of the main steam line. A gland, *D*, forced downwards by the nuts, *E*, *E*, on the stud bolts, *F*, *F*, compresses the packing, *G*, in the stuffing box, *B*, thus preventing leakage of steam between the pipes, *A* and *C*, yet at the same time allowing the pipe, *C*, to slip into or out of the section, *A*, as the changes in temperature alter the length of the main.

There is a pressure on this joint in a

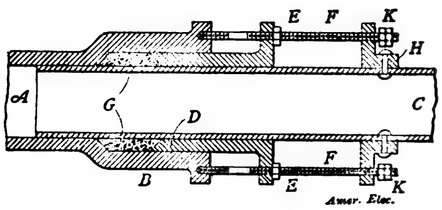

FIG. 7.

longitudinal direction, equal to the internal area of the section *A* times the steam pressure in pounds per square inch. This force tends to separate the sections *A* and *C*. The effect of parting these pipes, under full steam pressure, would be disastrous. To guard against any such possibility, the studs, *F*, *F*, are made very long, so as to extend back through the flange, *H*, riveted firmly to the pipe, *C*, and are fitted with nuts, *K*, *K*, which just miss touching the flange, *H*, when the pipe is cold. The pipe, *C*, is thus free to move longitudinally to accommodate the change of length of the main, yet it cannot slip wholly out of the section, *A*, because of the restraining nuts, *K*, *K*. It is possible to balance this form of joint simply by the steam pressure in the pipe, but the construction is considerably more complicated and the cost made correspondingly greater.

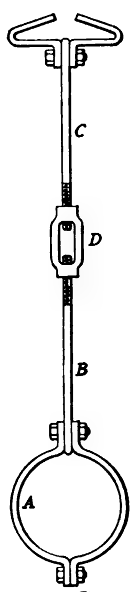

FIG. 8.

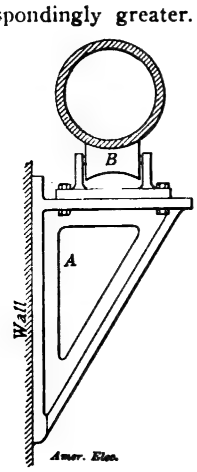

FIG. 9.

It is noticeable that the type of expansion joint shown in Fig. 7 is being employed to a far less extent than formerly, the long bend being the ordinary means of taking account of expansion. The reason for this lies in the fact that the packing in the slip joint is apt to grow hard, and eventually leak. Also, there are cases in which the slip joint failed to slip as it ought, with the result that walls were demolished. The cost of a good expansion joint of this class is another disadvantage, when compared to that of a bend of pipe. It should be used only in places where the other forms are out of the question.

There are various methods of hanging or supporting pipe lines so as to enable the expansive movement to take place without damage to the pipe. In case the main is suspended from girders of roof trusses, the form of hanger shown in Fig. 8 is frequently used. It consists of a ring, *A*, of flat iron, made in two parts, which after being put around the pipe are bolted together. The upper bolt passes through the eye of an eye-bolt, *B*, which is connected to a second eye-bolt, *C*, by the turnbuckle, *D*. These eye-bolts are made of round iron with welded eyes and have right and left-hand threads, respectively. The upper one is joined to two straps which hook over the flanges of an I-beam and are held in place by a bolt and nut. When a pipe is suspended by a number of these hangers, the movement due to expansion or contraction simply swings the rods, *B* and *C*, about the upper point of support.

If the pipe line is supported on brackets, as, for example, when it is carried along a wall, then some arrangement like that shown in Fig. 9 may be used. The bracket *A*, is secured rigidly to the wall. It carries a cast-iron roller, *B*, whose curvature is the same as that of the pipe. The pipe being anchored at the middle of its length, expansion in either direction simply turns the roller, *B*, as the movement occurs, thus preventing any binding of the pipe. Means of adjusting the roller in any direction should be provided. This may be done by wedges and by oblong bolt holes in the plate carrying the roller.

THE POWER PLANT OF A MODERN TELEPHONE EXCHANGE.

BY A. DALLAM O'BRIEN.

The introduction of the common-battery telephone system brought with it the necessity for a source of power at the central office, and as each additional refinement of the system has been perfected, greater and more varied demands have been made on this central source of power, until at the present time every modern central office has incorporated in it a power plant which is in its way a most complete installation.

It is of the utmost importance that the current which is furnished both to the operators' transmitters and to the subscribers' lines for talking purposes should be furnished at a constant potential or a potential whose variations at each succeeding instant shall not be of sufficient magnitude to affect the sensitive transmitter; and for this purpose there is no source of power which so pre-eminently fulfills the requirements as does the storage battery. As a consequence the basis of all central office power plants is the storage battery, and the differences which may be observed between various plants will be largely in the method employed for charging the batteries.

A potential varying from 20 to 24 volts may be considered as the standard in use

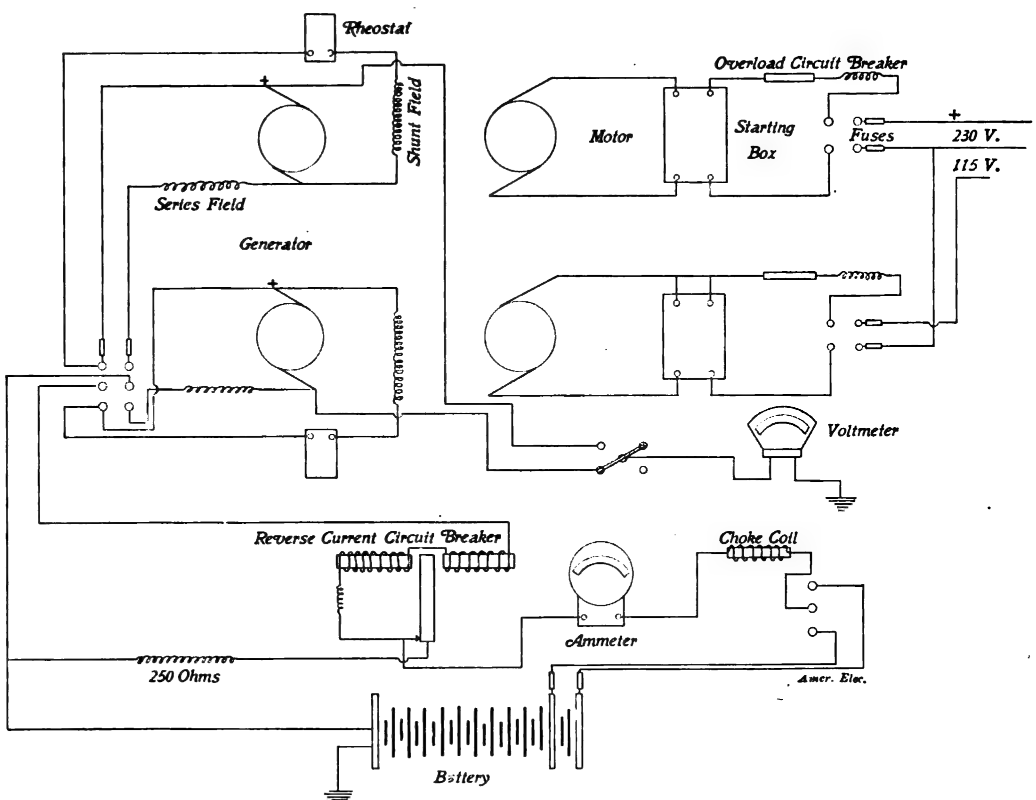

FIG. I.—DIAGRAM OF CONNECTIONS FOR CHARGING CIRCUIT.

to-day, both for the current furnished to the line for talking purposes and also for operating the signalling apparatus at the exchange. If the voltage of each cell is taken as 2.5, when the cell is fully charged, it will be seen that in order to obtain a 24-volt battery it is necessary to employ ten such cells connected in series, and further, if the discharge from the battery is con-

tinued until the voltage per cell drops to 1.8, two additional regulating cells will be required in order to maintain constant constant at all times a potential of 24 volts.

From the above considerations, it will be apparent that in order to maintain at all times a constant potential of 24 volts, and at the same time discharge the batteries until the voltage per cell drops to 1.8, there will be required a battery consisting of twelve cells. two of which are used solely for regulating purposes and may be arranged so as to be automatically cut in or out of the circuit as the condition of the battery requires. In designing the battery equipment for a given office, the size of the cells to be used will, of course, depend upon the output required of the battery, and this in turn is a direct function of the number of originating calls and also depends upon the distribution of these calls throughout the period of twenty-four hours during which the battery is called upon to furnish current. It is probably safe to consider that during each connection which is completed at the exchange a current amounting to 2/5 of an ampere is drawn from the battery, and if three minutes (which is considerably greater than the average) be taken as the average length of connection, the output of the battery for each completed call amounts to 1/20 × 2/5 or 1/50 ampere-hours. From these data, and knowing the number of originating calls and the maximum number of calls during any one hour, the capacity or size of the battery necessary to supply the needs of the office may be very closely approximated.

The size of cell having been determined, the next question that arises is the method to be employed in charging the battery, and as it is of the utmost importance that every possible precaution should be taken to insure the absolute readiness of the battery for service at all times, at least two possible means of charging should be provided so that in case of the failure of one arrangement the other may be called into play. Where an outside source of current is available, it may readily constitute one of the means of charging, the other means being located in the office itself.

For the inside source of power the gas or oil engine is ordinarily adopted as it requires no boiler plant and comparatively little attention. In very small offices, which constitute one of a group in which there are one or more large exchanges, the batteries may, in case of necessity, be charged from one of the other offices, and thus it is possible to dispense with more than one source of power. In large offices, however, where the originating calls amount to 15,000 a day or more, every precaution to insure the continuity of service should be taken; two motor-generator sets, consisting of a motor and generator direct-connected on the same shaft, should be provided. In addition to these there should be an engine-driven unit, consisting of a generator either belted or direct-connected to a gas, oil or steam engine, according to the conditions which govern the installation. The motors which drive the charging machines should be so arranged that they may be driven either by means of current furnished from some outside source or else by the current furnished from the generator located in the exchange building. It may often happen that the voltage of the outside source differs from that furnished by the generator in the exchange, and in this case the motor-generator sets may be so arranged that one will operate on the outside current and the other upon the current furnished by the exchange generator. A typical arrangement of a charging circuit of this kind is shown in Fig. 1, this circuit being an example of an actual installation in an exchange handling 20,000 originating calls per day.

From an inspection of this diagram, it will be seen that in this case the outside source of current has a potential of 230 volts, while the office generator delivers current at 115 volts. The generators are compound-wound machines and are connected to the charging circuit by means of a double-pole, double-throw switch, which allows of throwing either generator on the circuit at will. The positive side of the charging line to the battery is connected through a polarized relay which operates at once to break the circuit in case the potential of the battery rises above that of the charging generator, and the battery in consequence tends to run the charging machine as a motor. In addition to this a choke coil is connected in series with the positive side of the charging line and serves to prevent sudden variations in the potential of the charging current from affecting the battery.

There are a number of other small generator units which go to make up the power equipment and these are usually so designed that they may be driven by the 24-volt current from the battery. These small machines are used for a number of different purposes; there are usually two ringing machines which consist each of a single double-current machine which is arranged with two windings on the same armature, the same field serving for both windings. One winding is connected to a commutator and serves as the direct-current motor armature which is driven by the current from the battery, while the other winding terminates in collector rings and furnishes alternating current at 75 volts for ringing purposes. In some cases, instead of using the double-current machines described above, direct-connected units, consisting of a motor and a generator, are used for the same purpose.

In addition to the machines for furnishing ringing and charging current, there is also required a duplicate set of machines for supplying the interrupted current which is used for the "tone test," the "busy back," the "don't answer," and the "out of order" signals. All of these special signals require a continuous current which is interrupted a predetermined number of times per second in order that each signal may produce in the receiver a sound which is distinctly its own, that there may be no confusion as to the meaning of the different signals. For furnishing this current either a machine with a double winding may be employed or a direct-connected motor and generator unit may be used. In either case the current from one brush on the commutator is led to a brush on an interrupting ring, consisting of alternate strips of conductor and insulator, before being led to the switchboard.

The switchboard should consist of at least three panels, one for the charging apparatus, one for the auxiliary machines (the ringing and signaling apparatus) and one fuse panel on which are mounted the fuses in the different circuits as will be explained later. The charging panel should contain the main switches for the motors and generators, the overload circuit-breakers, which are in the positive side of the motor circuit, the motor-starting boxes, the generator field rheostats, and the fuses in the motor and charging circuits. In addition to this apparatus, the panel should be equipped with an ammeter for measuring the charge and discharge of the battery and a voltmeter and voltmeter switch arranged to measure the voltage at charge, the voltage at discharge and also the voltage of each individual cell of the battery. The panel for the auxiliary machines should be equipped with the main switches, starting boxes and field rheostats, the necessary fuses, and double-pole, double-throw switches arranged for throwing either group of machines upon the ringing or signaling bus-bars as necessity requires. The third or fuse panel performs a most important function, as it is on this panel that are located all of the fuses in the cord circuits, the ringing circuits and other auxiliary circuits which lead to the switchboard. On the back of this panel are arranged a number of sets of bus-bars connecting to the storage battery, to the ringing machines and to the signaling machines. These rear bus-bars are in turn connected to polished copper bars on the front of the board, the front bars being drilled and tapped for screws which hold the fuses in place. On either side of each bar is arranged a row of connectors which have a screw terminal on their front face and a lug on the rear of the board to which the wires leading to the various circuits may be soldered. The fuses are placed on the front of the board between one of the screws on the bus-bar and one of the screws in the row on either side of the bar. Each cord circuit has two fuses, one for the front and one for the back cord, and the fuses are so numbered on the front of the switchboard that the cord circuit may be readily identified. It is not customary to run a separate set of ringing leads to each position, but rather to connect two positions on each ringing circuit, allowing one position to intervene between each two so connected, so that there will be half as many ringing fuses on the switchboard as there are positions in the central office. In the same way the tone test circuits, the busy back, the don't answer and the out of order circuits are run from the fuse panel, there being two positions on each circuit. The connections to the lugs on the back of the board are made by sewing up the outgoing circuits

in the form of a cable and fanning out the terminals on either side, so as to connect by means of a soldered joint to the lugs, there being one such cable for the ringing circuit, one for each auxiliary circuit and usually several for the cord circuits. These latter are carried directly to the repeating coil rack, where their terminals are connected to the proper terminals of the coils.

The switchboard is preferably located in the wire chief's room, in as close proximity to the testing desk as possible, in order that the wire chief or his assistant may hear if possible the blowing of a fuse and in any event upon receiving a report of trouble in any circuit, may be able to see immediately from an inspection of the switchboard whether the trouble is the result of the blowing of a fuse. In addition to the circuits already mentioned, the trunk circuits are also fused on this panel, and it requires no great stretch of imagination to see that in a large office more than one fuse panel will be absolutely necessary. The addition of a recording ammeter to the switchboard equipment is of considerable value as furnishing a check upon the peg count and upon the estimated current consumption; it adds largely to the information needed by the engineering and operating departments of a telephone company.

Switchboard panels in telephone offices differ as widely as do those in power plant service. They may be made either of white marble or slate and are usually mounted in an angle iron frame which is bolted to the floor and is held in place by rods or angles fastened in the wall. The switchboard for the exchange generator is not as a usual thing located in the same room, or indeed in the same part of the building, as the rest of the apparatus. This board should consist of one panel containing a voltmeter, an ammeter, a circuit-breaker, a field rheostat, the necessary fuses, and a double-pole, double-throw switch. The leads from the generator should be connected to two of the terminals of this switch and the outside source of supply to two other terminals, the two central terminals being directly connected to the switchboard in the wire chief's room. By this arrangement it is possible to at once change the source of current from the inside to the outside supply or vice versa, this being a sufficiently flexible arrangement to provide for most emergencies.

The charging of the batteries is usually done either at night or in the early morning during a period of light load, as with a heavy demand upon the battery for current there is as a general thing some disturbance which manifests itself in the form of a buzzing noise on the subscribers' lines when the batteries are being charged, and consequently it is customary to confine the charging as far as possible to times when the exchange load is light.

Should trouble occur in the storage battery it is quite possible to supply the current to the switchboard bus-bars directly from the charging generator, and by inserting a choke coil of low resistance and high impedance in the circuit the variations of potential in the current furnished by the generator can be smoothed out sufficiently to allow the exchange to operate during an emergency. The batteries themselves are usually located in the wire chief's room and close to the switchboard. Owing to the sulphuric acid fumes which are given off when charging, they are usually enclosed in a wooden cabinet which is kept sealed as tightly as possible and which is provided with a ventilator for carrying off the fumes to the outside air.

TABLE I.—Cost of Power Plants Based on Number of Originating Calls.

Originating calls	7200	9000	13500	27000	36000	50000	65000	80000	100000
Amp.-hrs. per day	800	890	1140	1880	2400	2940	3765	4595	5695
Size of cell	G-15	G-15	G-15	G-25	G-31	G-39	G-51	G-51	G-51
Charge rate amp.	....	....	....	....	....	380	500	500	500
Discharge, night, amp.-hrs.	....	....	....	....	....	735	941	1150	1425
Discharge, day, amp.-hrs.	....	....	....	....	....	2200	2800	3450	4250
Average discharge, day	....	....	....	....	....	220	280	345	425
Amp. cap. chg. set	....	....	....	....	....	400	500	600	800
Type	M-4	M-4	M-4	M-5	M-6	K	L	N	O
COST.									
Battery	1400	1400	1400	2050	2500	3000	4100	4100	4100
Power, machine	950	950	950	1050	1900	1900	2050	2400	2900
Power, switchboard	450	450	450	450	550	600	700	800	1000
Installation	1000	1000	1000	1000	1000	1260	1600	1691	1931
Ringers	450	450	450	450	450	450	450	450	450
Total	4450	4450	4450	5000	6400	7210	8900	9441	10381

The charging machines are usually of sufficient size to warrant being set on a foundation of their own, while the auxiliary machines being of small capacity and small size are usually grouped on an angle-iron support or table which raises them to a level of about three feet above the floor, so that they may be readily inspected and repaired. The cables from the battery to the switchboard and from the machines to the board are run in iron conduit which is laid under the floor, the power room floor usually being of concrete and the conduits being put in place before the floor is laid, the cables being pulled in later. Where the telephone exchange is located in a building which is used entirely for the purposes of the telephone company and where the building is of sufficient size to warrant the installation of an isolated plant for lighting, the question as to the advisability of installing a boiler plant and driving the generators by means of steam engines is oftentimes one that requires little consideration for its settlement. The exhaust steam may be utilized for heating and where this is not sufficient, live steam may be added to make up the required amount, and the boiler plant fulfills several functions. There are a number of telephone companies operating at the present time a steam-electric plant in their office and exchange buildings, the plant not only furnishing the power for lighting and charging the central office storage batteries, but also utilizing the exhaust steam for heating as outlined above. A typical plant of this kind consists of probably 200 horse-power in water-tube boilers, two direct-connected steam-electric units of from 60 to 80 kilowatts, one unit being run continuously and one held in reserve. The engines are usually of the simple high-speed type running at from 250 to 300 r.p.m., and the generators direct-current machines with voltages ranging from 110 to 220. With a plant of this kind the telephone company can be independent to a very large extent of any outside source of power and at the same time can utilize any other existing source of power in case of some unforeseen emergency. There is one requisite in connection with telephone service that is of prime importance, and that is continuity of service, and almost any precaution which may be taken toward this end will be justified by the results obtained.

The figures given in Table I show the size of the plant necessary for an office having a given number of originating calls, and also the cost of the various items which go to make up the equipment and the cost of installing the machinery. The size and type of the storage cells are given according to the standard of the Electric Storage Battery Company. It will be noticed from this table that the ampere-hours required per call do not agree with the figures given in the early part of this article, this being due to the fact that the former figures include only the current used in the talking circuit, while the figures in the table include all the current which is drawn from the battery for talking, signaling and operating purposes.

AUTOMATIC BLOCK SIGNALS.

BY RALPH SCOTT.

Standard Electro-Gas Signal Construction.

The standard Hall electrogas signal, which is recognized by most signal engineers at the present time as the very highest development of the automatic semaphore signal, was first placed in service on the Lehigh Valley Railroad at Buffalo in the early spring of 1902, since which time it has been giving excellent service. The general design of this signal is somewhat similar to that shown in Fig. 65.

The only similar signal in operation, up to this time installed, was the electropneumatic signal, which is operated directly by pneumatic power, the valves allowing the air to exert its pressure upon the semaphore cylinders; these valves being operated by electromagnets. The advantage of this type of signal was the direct reciprocating motion, and the enormous power, which was not readily overcome or diverted by the ordinary difficulties met with in signal service. The disadvantage of this type of signal, however, was the great initial cost of the air pipes and compression locally and the signals themselves being entirely isolated, and independent of all other signals installed. This rendered unnecessary a central point or station from which the power was distributed over a necessarily limited area to the signals. A disadvantage, however, of the motor signal

was the fact that a large amount of gearing was necessary to transform the rotary plant, and the liability of the moisture contained in the air being deposited upon the valves or small outlets, and the consequent

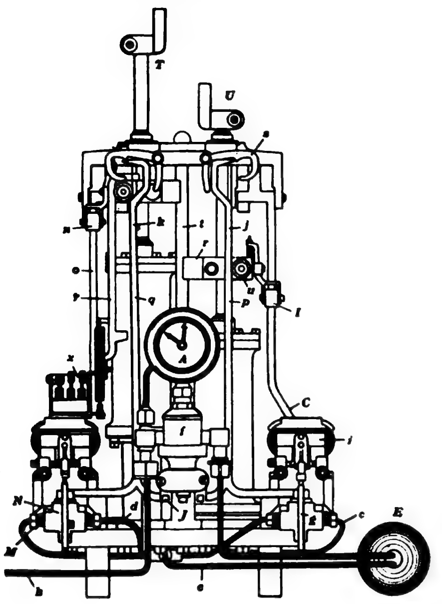

FIG. 67.

freezing at these points in very cold weather.

These facts led to the almost universal adoption of the electric motor signal, which although not as powerful as the electropneumatic, was much more to be depended upon, the power in this case being applied motion of the motor armature into a direct reciprocating motion for the movement of the semaphores.

Also, on account of the low voltage of the circuits employed, it was a very simple matter for the brushes to become insulated from the commutator, either by a thin layer of dust or frozen moisture or by the contact of the brush upon one of the mica bars insulating the commutator. Thus, the advantages of the electric motor signal were gained through the acquisition of a number of inherent difficulties.

One of these difficulties appears in the electrogas signal, which combines the great reserve power of the electropneumatic with the simplicity and isolation of the electric motor signal. The power for operating the electrogas signal is liquid carbonic acid gas, which is a very familiar and simple means of obtaining great power.

On account of its extensive use for soda water and other purposes, it is comparatively inexpensive and capable of being readily transported. It can also be stored for any length of time without the slightest depreciation. It has also a very high expansive power, which may be easily regulated by special valves.

The expansion is not attended by any precipitation of moisture. In fact, the greater the expansion the greater its ability for drying any moisture which may be present. Especially is this true when exhausting; any moisture which happens to be deposited in the pipes through which it passes being rapidly absorbed, and thus fortunately removing one of the greatest difficulties that has been met with in any type of signal—that is, the liability of clogging the moving systems by the freezing of the moisture present.

With these objects in view, it is very evident that liquid carbonic acid gas forms an ideal motive power for a mechanism that is intermittently operated, but which must be absolutely accurate in these operations.

One of the greatest difficulties which was met with in forming the electrogas signal was the construction of a valve which would not allow the gas at the comparatively high pressure at which it is used to leak through these valves at the time that the signal was not in operation.

A section of one of these valves as actually constructed is shown in Fig. 71.

The construction of the electrogas signal requires the same standard accessories as do all forms of motor signals.

The flasks employed are about 4½ feet long and 8½ inches in diameter. These

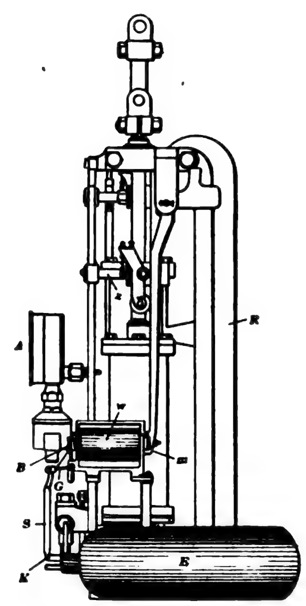

FIG. 68.

flasks are placed in the ground at the base of the signal, in an iron chute. When fully charged they weigh about 150 pounds and contain approximately 50 pounds of liquid gas. The pressure in a newly charged flask is about 800 pounds per square inch, which, however, is reduced through the reducing valve to about 40 pounds, which is the pressure required for signal operation.

To prevent the explosion of a flask when left in a heated position or during rough handling, they are provided in their upper extremity with a safety valve which releases at 2400 pounds pressure. If the flask were left near a locomotive boiler or in the hot sun, this safety valve would operate.

The actual construction of the most approved form of electrogas signal is shown in Figs. 67, 68 and 69. In Fig. 67 a front elevation of the mechanism required for the operation of two semaphores, which is the case with the home and distant signal is shown. The semaphores themselves and the signal pole are not given in this view, the rods connecting with the signal arms through a long vertical rod. The vertical cylinders are the means through which the power is applied to the movable piston, which moves the semaphores to their clear or danger positions.

The cylinders themselves are movable and are fastened directly to the rods operating the semaphores, the piston being rigidly fixed to the base of the mechanism frame. The gas which enters through the small pipe in the center of the piston causes the cylinder to move upward, thus placing the signal semaphore to the clear position. The gas is admitted to the working cylinders by means of a valve which is operated by an electromagnet. These electromagnets are energized by means of current taken directly from the track in the usual manner, forming virtually the track relay and controlled only by the track circuit.

The magnets for the home and distant signals are shown respectively at the right and left of the elevation. When the signal has been moved to the clear position, it is held in this position by means of curved levers and latches which are held in place by the relay itself. The distant signal is cleared after the home signal has been moved by means of a switch which is operated by the movement of the levers fastened to the home signal.

In Figs. 68 and 69 the mechanism of this signal is shown, which represents a partial section and side elevation. A frame, *R*, forms the housing for the cylinder and piston, *a*, the pedestal, *b*, supporting this piston; through the center of which the pipes *c* nd *d*, supplying gas to the cylinder pass. The pipe, *e*, leads from the reducing valve, *f*, directly to the expansion chamber passing from the latter to the valves *g*, which are electrically controlled; that is, through the armatures of the relays. The pipe, *h*, connects the supply tank directly to the reduring valve; the armatures, *i*, of the relays operating the valves, *g*, by means of *S* and the other connections shown in Fig. 68. The latch, *l*, which is shown in section, holds the signal clear by engaging with the clutch lever.

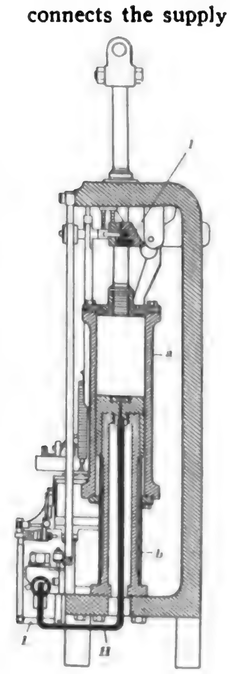

FIG. 69.

The clutch armature is shown at *M*. *n* and *I* are two buffer levers which prevent this clutch lever from striking the magnet ends when the signal passes to the danger position. They also hold, at a short distance from the poles of the magnets, the clutch armature, which prevents the signal while at the danger position from freezing fast in case moisture condenses on these clutch armatures in cold weather.

The levers, *p* and *q*, are for the purpose of

cutting off the supply of gas from the working cylinder, and also for allowing it to escape when the signal has reached the full clear position. These levers are controlled by means of the pawls, *s*. The clutch casting, *r*, is rigidly fastened to the cylinder rod so that the stroke of the cylinder will not be changed after being set. It also carries the roller, *u*, which engages with the pawl *s*, when the cylinder has reached the upper position, and thus cuts off the gas, the amount of movement of the cylinder being dependent upon the position of the clutch casting, *r*.

The front armatures of the magnets, *W*, operate the gas valve, the rear valve holding the signal in the clear position through the long lever shown. The electric switch, *X*, which is placed on the top of the left-hand magnet, is operated by the rod, *y*, whenever the latter is engaged by the stud, *z*. This switch is not shown in the front elevation. The gauge, *A*, on the reducing valve, *f*, is provided with two pointers, which move over two different dials, and indicate respectively the pressure in the supply tank and the pressure at which the signal is operated, which, as stated before, is in the neighborhood of 40 pounds.

When the signal is moved to the clear position, the magnets, *w*, become energized, the armatures, *B* and *I*, being attracted, thus opening the valve by means of the connections, *G* and *S*. The exhaust valve (refer to the section shown in Fig. 71) is then forced against its seat, the supply valve at the same time being opened, thus allowing the gas to enter the cylinder through the pipe, *H*.

This causes the cylinder to move in its upper position and puts the semaphore at the clear position.

As soon, however, as the latch, *l*, has moved past the toe of the clutch lever, *k*, the roller, *I*, raises up the pawl, *s*, thus allowing the cut-off lever, *q*, to move to its lower position. This cut-off lever being engaged with the nut, *J*, forces downward the links, *K* and *L*, thereby opening the exhaust valve, *M*, and closing the supply valve, *N*. The entire weight of the moving signal is now exerted upon the latch, *l*, at which position it is engaged with the clutch lever, being thereby held in the clear position, by reason of the energization of the clutch magnets, which hold the armature, *m*.

The switch, *X*, which reverses the current in the magnets after the signal has moved to the clear position is operated by means of the stud, *z*, thus raising the rod, *y*, and moving through an arc the switch shaft, which thereby changes the contacts. When the contacts become de-energized, as will be caused by the entrance or movement of a train in the section to which they are connected, the armature, *m*, is released, thus allowing the clutch lever, *k*, to move backward, and causing the latch, *l*, to pass the toe of the lever. This allows the signal to drop to the danger or the stop position by gravity.

As soon as the check valve, *Q*, shown in section in Fig. 71, has been partly closed, the cylinder acts in the same manner as a dash-pot, the exhaust gas at the same time bleeding through the narrow port, and bringing the signal gradually to a position of rest.

The purpose of the expansion chamber, which is connected immediately between the reducing valve and the valve controlled by the magnets is two fold; first, it allows the gas coming from the flask to expand to a lower pressure, before passing through to the cylinder, and thus by reducing the consequent pressure, allows its expansion to be more fully used. Second, it decreases the liability of the gas from taking heat before passing to the controlling valve, and thus causing the condensation or freezing of any particles of water which might be present.

The slow expansion, on the other hand, does not utilize much heat, but more evenly distributes the difference in temperature. If, however, freezing should occur, the frozen water is in a very finely divided state, which usually does not prevent the movement of the cylinder.

The area of the piston itself is five square inches which, therefore, produces a pressure in the direction of motion of 200 pounds, which also allows a large margin for the prevention of motion of the semaphore by sleet or frost. By increasing the working pressure at the reducing valve, this margin may be increased to any desirable figure. A fifty-pound charge will produce about 12,500 signal movements.

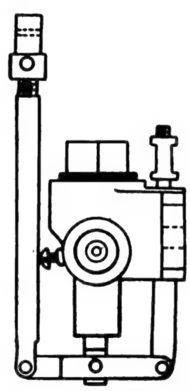

FIG. 70.

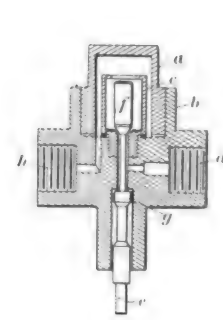

FIG. 71.

As we have already shown, the relay magnet performs two functions: first, holds the magnet clear; and second, operates the valve which controls the admission of gas to the cylinder. The amount of energy required to perform both these functions is very small, and seldom, in any case, exceeds 1/10 watt.

Less energy is required to hold the signal at clear, owing to the great leverage of the clear position armature, and to the fact of the winding on the magnets being double. These windings are connected in series, to hold the signal at clear, and in multiple, when the operation of the valve is required. This change in connection is brought about by the levers, which act upon the reversing switch.

When the signal is used in connection with the polarized relay or wireless track circuit system; when one of the windings is disconnected from the batteries, it is immediately short-circuited, the self-induction of the core thus preventing the magnet from being demagnetized, thus holding the armature for a short time before being released. This holds the signal at the clear position sufficiently long to prevent the signal mechanism from moving to the danger position when the polarity of the track system is changed.

The arrangement of a three-position signal movement is somewhat similar to the home and distant arrangement above described, a walking beam being introduced, with the utilization of only one signal rod. When the home signal is cleared, the blade moves at an angle of 45° with the signal post; and if the distant signal moves to clear, the walking beam, by an increase in leverage, moves the signal rod parallel with the signal post or at an angle of 90° with the danger position of the signal.

One of the greatest advantages of the electrogas signal is the steadiness and extreme rapidity with which it moves to the clear position. The time consumed varies from one to two seconds, according to the amount of gas which is allowed to pass the valve, this amount being adjustable.

The semaphore movement, when compared with the electric motor signal, of which the power applied decreases as the rotation of the armature increases, is much more uniform. The battery current, which is necessary to operate the clutch magnets, is .018 ampere, after the signal has moved to the clear position. Two windings, as above stated, are provided in the clutch magnets — the high-resistance winding, which is obtained by connecting the windings in series, is used to hold the signal in the clear position and the low-resistance winding obtained by connecting the windings in multiple is used to clear the signal by operating the valves, etc.

In the light in which the electrogas signal is considered, it seems fair to assume that before long either this signal or a modification of it will be used by nearly all railroad systems as standard.

Gas Valve.

An end elevation of the valve employed in the electrogas signal is shown in Fig. 70. To more clearly describe the parts of this form of valve a section is given in Fig. 71. The lever from the armature of the electromagnet is connected to the valve stem, *f*, at the end, *e*. The end, *h*, connects, by a short pipe, to the reducing valve, which in turn passes to the gas flask. When the armature of the relay is attracted, the end *f* is raised from its seat, thus admitting gas from *h* to the chambers, *a* and *c*.

At the same time the exhaust valve is closed by the action of *g*, which moves against its seat. Gas then passes from the chamber, *a*, to the threaded end, *d*, which passes to the cylinder of this signal. When *e* returns, on the cessation of the current in the relay, the exhaust is started at *g*, thus allowing the air to pass from the signal cylinder. At the same time, the admission of air is prevented by the closure of *f*. The pressure of the gas holds *f* in its lower position until overcome by the movement of the relay armature.

Abstracts from Foreign Contemporaries

Blow-off Cock for Boilers.—*Engineering* describes the simple form of blow-off cock for boilers shown in two views by Fig. 1, one being a vertical longitudinal section and the other a sectional plan. The following advantages are claimed for the

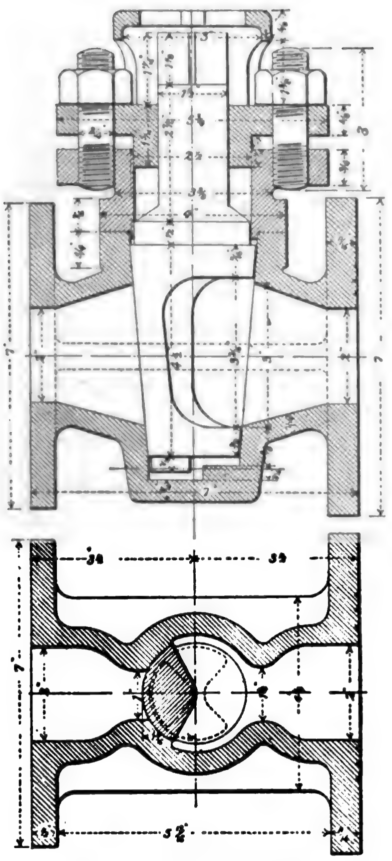

FIG. 1.—BLOW-OFF COCK.

cock: (*a*) When shut, none of the working surfaces are exposed to the water in the boiler, and, therefore, no dirt or scale can be deposited on them, and there is no scoring of the faces, no leakage, and no stiffness of action; (*b*) the gland is compound, the stuffing-box being formed by a detachable part, which is bolted to the body of the cock, thereby enabling the packing to be renewed while the boiler is under steam. (*c*) There is a safety lock which prevents the key from being removed unless the plug is properly closed. It will be seen on reference to the illustration that the advantage (*a*) is secured by cutting away the plug on the boiler side, so that its wearing surface does not extend beyond the wearing faces on the casing, the casing being enlarged in bore beyond its faces, which extend no farther than the solid part of the plug, when the latter is closed. The cocks have been extensively used both on high and low-pressure boilers.

Automatic Insulation Testing Device.—The London *Electrical Review* describes an automatic insulation testing device, the arrangement of which is shown by Fig. 2 herewith. The apparatus is applicable to all installations where both conductors are insulated, whether direct current or alternating current, and may also be used in central power stations to supplement or replace the Hopkinson two-lamp indicator, whose function it closely parallels. The current from the supply mains passes through conductors, of which a few turns are wound round the ends of a glass tube, *T;* the tube contains a liquid upon the surface of which a float, *F,* supports a small magnet, *M,* a guide, *G,* preventing the float from clinging to the side by capillary attraction. A disc, *D,* is attached to the float, to indicate its movements. The float is controlled by a magnet, M^1, so as to stand normally central when the insulation of the circuit is unimpaired, the currents in the coils neutralizing one another's action. If now a leakage occurs on either side of the system on the leads, *s* or s_1, whether a load is on or not, the go and return currents in the coils will no longer be equal, and the float will be attracted toward that side on which the leakage occurs, the displacement being approximately proportional to the magnitude of the leak, and being permanent so long as the leak exists. Directly the leak is removed, the float returns to the mid-position. If both sides of the circuit are faulty, the float will move toward the

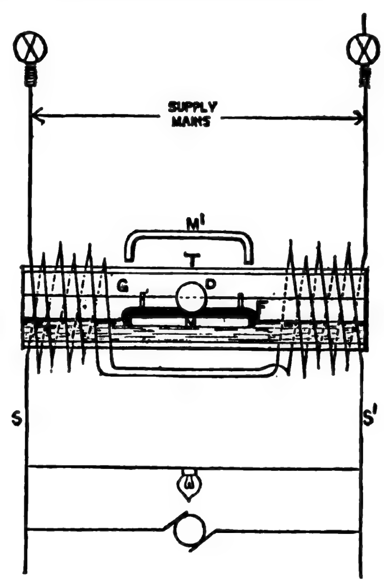

FIG. 2.—INSULATION TESTING DEVICE.

side on which the greater leakage exists—the case of exactly equal leakage of any material magnitude is so unlikely to occur for any length of time, that it need hardly be considered. An alarm signal or automatic cut-out can, of course, be easily operated by contacts made by the float at suitable positions in its travel. The apparatus is very simple, and not likely to get out of order. A model of it was appreciably affected by an artificially-produced leakage of 1-40 ampere, and obviously a growing leak would be distinctly indicated long before it attained a magnitude capable of doing injury.

Electromagnetic Relay for Voltage Regulators.—The *Elektrotechnische Zeitschrift* contains an interesting article on an electromagnetic relay for voltage regulators. The new arrangement for direct current, shown by Fig. 3, is described. + and — are the two points where the voltage is to be held constant. m_1 and m_2 are two electromagnets and the resistances, w_1

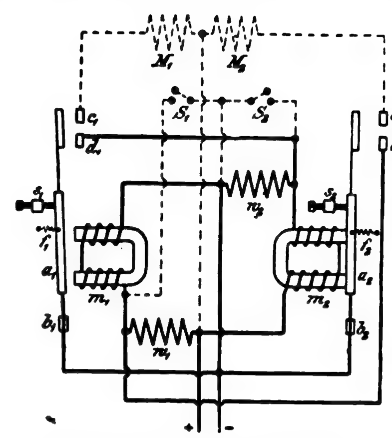

FIG. 3.—ELECTROMAGNETIC RELAY.

and w_2, are inserted between the points + and — and the windings of m_1 and m_2, respectively. m_1 is the magnet which is intended to close a contact when the voltage becomes too high. m_2 is the magnet which shall close a contact when the voltage becomes too low. The position of the different parts of the apparatus shown in the illustration is for normal voltage. The armature, a_1, is in this case not attracted by m_1, and is pressed by means of the spring f_1, against the screw s_1, so that the contact, c_1 d_1, is broken. The armature, a_2, is attracted by m_2, and rests against the screw, s_2, while the spring, f_2, tries to draw it back. The contact, c_2 d_2, is therefore also broken. Rough adjustment is made by means of varying the tension of the spring, f_1 and f_2, more exact adjustment by means of the screws, s_1 and s_2. The adjustment of s_1 and f_1 determines the highest voltage to which the e.m.f. is is permitted to rise; the adjustment of f_2 and s_2 determines the lowest voltage to which it is allowed to fall. Should the voltage rise above the higher limit, a_1 is attracted by m_1 and connects b_1, c_1 and d_1. Thereby the switching device is supplied with current which is assumed to be operated by an electromagnet, the left magnet, M_1, being acted upon in this case. This accomplishes the desired diminution of the voltage and at the same time closes the switch, S_1. The winding of m_1 is thereby short-circuited, so that it is no longer magnetized and the armature, a_1, returns to its normal position, being drawn back by the spring, f_1, the circuit of M_1 being now interrupted. Thereby the switching device is also brought back to its normal position and the switch, S_1, is again opened and the original condition has thus been reproduced except that the voltage has been reduced, so that the armature, a_1, is no longer attracted. In case the voltage drops below the lower limit, the right hand of the apparatus operates in a similar manner.

A New Dynamo Brush.—Of recent years the tendency in dynamo brush design has been towards the production of a brush combining the sparkless collecting properties of carbon with the high carrying capacity of metal. The *Electrotechnische Zeitschrift* gives the following particulars of a new brush patented by Messrs. Svenska, of Stockholm, which claims to accomplish this combination. It is known as the bronze-carbon brush, but the mass of the brush does not consist, as the name would seem to imply, of a mixture of powdered bronze and powdered carbon, but of pure powdered graphite, of which each separate particle is first covered with a coating of copper and then with one of tin. The method employed for coppering and tinning the particles is a trade secret. After this process is completed, the powder is hydraulically compressed in a dry and cold state, and without any special binding material, into the required shape. The hardness of the brush can be varied at will during this operation. Afterward the brushes are heated sufficiently to cause the copper and tin coatings to combine and form a bronze coating. In this way every particle of graphite powder receives a coating of bronze, but the smallness of these particles keeps the material quite homogeneous. It will take a polish and is readily soldered, and also possesses lubricating qualities owing to the presence of about 20 per cent of free graphite. Tests carried out at the Government Laboratories in Stockholm have proved that the conductivity and the contact resistance of these brushes are the same as those of ordinary plate or gauze brushes. Curves connecting watts lost in ohmic resistance with the peripheral speeds of the commutator in meters per second at current densities of 1, 5 and 10 amperes per square centimeter, respectively, both for ordinary carbon brushes and for bronze-carbon brushes, show that the difference between the two types of brush is especially marked at the higher current densities. For instance, at a peripheral speed of 15 meters per second and a current density of 10 amperes per square centimeter, the loss with ordinary carbons was 34.5 watts, while with the bronze-carbon brushes, under the same conditions, the loss was only 3.4 watts. With regard to sparkless running, it has been found that the bronze-carbon brushes behave as well as pure carbon brushes, and replacing the latter by brushes of the same size and shape, but made of bronze-carbon, does not affect the running of the machine. The rate of wear of these bronze-carbon brushes is slightly greater than that of metal brushes, but, on the other hand, the wear of the commutator is much less.

Electric Driving of Wood-Working Shops.—*The Electrician* of London, in an article with the foregoing heading, gives some interesting results obtained from the use of electricity as motive power in two English wood-working shops. On account of the very intermittent character of the load in such shops electricity is peculiarly applicable, and the resulting economies are so great and readily apparent that the wonder is that any other means of driving should be at all considered. There is nothing unusual with regard to the general arrangement of the motors and driving gear, except that the motors and their starting and regulating rheostats are, of course, suitably enclosed in order to keep sawdust from interfering with the smooth working of the installation. In a Gravesend shop, there are five motors, all semi-enclosed and compound wound, with the exception of a ½-h.p. motor, which is shunt wound. The potential of the supply is 460 volts.

The circular saw bench can take any size of saw up to 3 ft. in diameter, and the maximum thickness of wood which may be cut is 13 in. This machine is driven at about 1000 r.p.m. by a 12-h.p. motor placed in a brick-lined pit underground, and power is transmitted by a 5-in. link-leather belt, this belt being completely enclosed by a wooden casing. It was found that the saw bench, when taking a 10-in. cut at the rate of 6 ft. per minute on 10 -in. by 7-in. damp pitch pine, required 13.8 brake-horse-power to drive it. The results of some further tests will be found in the following table:

Average amperes taken by motor.	Kind of wood.	Depth of cut.	Length of timber.	Time in secs.	Size of saw.
4.25	Motor and saw running light.				24 in. × 1⅛ in.
6.0	Motor and saw running light.				36 in. × 3/16 in.
13.5	Deal	6½ in.	10 ft.	25	24 in.
12.5	Deal	2 in.	7 ft.	7	24 in.
11.3	Pitchpine	5 in.	6 ft.	15	24 in.
18.7	Deal	9 in.	6 ft. 6 in.	43	36 in.
12.5	Deal	3 in.	5 ft.	8	36 in.

The tenoning machine is driven at 2700 r.p.m. by a link belt from a 5-h.p. motor running at 1200 r.p.m. This machine can do various kinds of work, according to the tools with which it is fitted at the time. When running light, its motor took 5.5 amperes, and when the machine was tenoning pitch pine, removing 3.5 cubic inches of wood in 10 seconds, the current consumption amounted to 9.5 amperes. A planer designed for 8 in. by 24 in. planks, is driven by belt from a 5-h.p. motor running at 800 r.p.m. The planer itself runs at approximately 4000 r.p.m. The following figures are the result of some tests:

Average amperes taken by motor.	Kind of wood.	Width of wood.	Thickness of cut.	Length of plank.	Time in secs.
2.5	Motor and planer running light.				
5.5	Pitchpine	9 in.	⅛ in. under cut	8 ft. 6 in.	25
5.2	Pitchpine	5 in.	¼ in. over cut	6 ft.	20

Another 5-h.p. motor, running at 1200 r.p.m., drives a band saw and a vertical spindle machine. Both machines are driven by belt and for this purpose the motor is provided with a pulley 20 in. in length, which is supported at its extreme end away from the motor by a third bearing. The vertical spindle turns at about 4000 r.p.m., and the speed of the band saw is 4800 ft. per minute. When driving the belts only the motor took 2.4 amperes, and when driving the belts and band saw, running light, 3.5 amperes. Some test results are tabulated below:

Average amperes taken by motor.	Kind of wood.	Depth of cut.	Length of wood.	Time in secs.
5.6	Deal	4½ in.	18 in.	10
7.0	Pitchpine	9 in.	19 in.	20
3.5	Motor and vertical moulding spindle running light.			
4.75	Motor, vertical spindle and band saw running light.			
3.75	Deal	Moulding extracted in the form of a triangle, the sides being ⅜ in., ½ in. & ¾ in.	11 ft. 6 in.	20
5.5	Pitchpine	2½ × ⅛	2 ft. 6 in.	20
3.5	Vertical spindle with rabbeting cutters used for the previous test on spindle running light.			

Electricity is also employed for lighting the shops. The amounts paid by the owners for the last two quarters for energy were £3 1s. 6d. ($14.94) and £2 12s. 11d. ($12.82), respectively. Another installation somewhat similar to the one described is driven by five shunt-wound semi-enclosed motors, the service supply being at 214 volts. A band saw is driven by a 3½-h.p. motor by means of spur gearing (raw-hide pinion) and a belt. The speed of the motor is 1250 r.p.m., and the gearing is such that the band saw runs at a speed of 3600 ft. per minute. When both motor and saw were running light the current taken was 4.5 amperes. Some interesting tests carried out with this machine are recorded below:

Average amperes taken by motor.	Kind of wood.	Depth of cut.	Length of wood.	Time in secs.
9.0	Deal	6 in.	2 ft.	25
7.5	Mahogany	2 in.	1 ft.	4
10.5	Oak	4¾ in.	1 ft. 6 in.	15
10.0	Beech	2¾ in.	1 ft.	15

The circular saw is driven by a 7-h.p. motor by spur gear only, and as the gear ratio is approximately 1:1, the speed at the motor shaft, *i.e.*, 1050, is the same as that at the saw spindle. Although the bench can accommodate a saw with a diameter of 24 in., the saw in actual use is 19 in. only, and when running light requires 7.5 amperes.

Average amperes taken by motor.	Kind of wood.	Depth of cut.	Length of wood.	Time in seconds.
17.5	Deal	2 in.	6 ft. 2 in.	10
14.0	Deal	1¼ in.	4 ft. 2 in.	5
15.0	Deal	1¼ in.	7 ft. 3 in.	8
18.0	Deal	6 in.	2 ft.	20

A French vertical spindle runs at the high speed of 5000 r.p.m., and is belt-driven by a 2½-h.p. motor running at some 1300 r.p.m.

Average amperes taken by motor.	Description of work done.
5.0	Motor and spindle running light.
6.0	Sash work in deal, cut ¼ in. deep by ¼ in. wide. Length of wood 7 ft. Time 15 seconds.
7.5	Motor and machine running light, but a large cutter (3 in. in diameter) fixed to spindle.
13.0	Ditto, moulding work.

Current in this latter installation is charged for at the rate of 3d. (6 cts.) per unit, and the actual cost of electric energy during the quarter was £4 6s. 10d. ($21.08).

Regulator for Solenoids.—*Engineering* contains a patent note of a regulator for rendering more equable the movements of the cores of solenoids employed for controlling or regulating electric circuits in any of the forms of apparatus in which the movements of cores inside solenoids are employed for effecting the regulating or controlling operations. The cores or plungers of the solenoids are made a moderately close fit, and are arranged to move up and down within tubes of metal arranged within the solenoids and closed at the bottom. The tubes within which the plungers or cores move are connected at the bottom by a pipe which can be fully or partially opened by a cock. The tubes in which the cores move are partially filled with oil or other suitable liquid. The

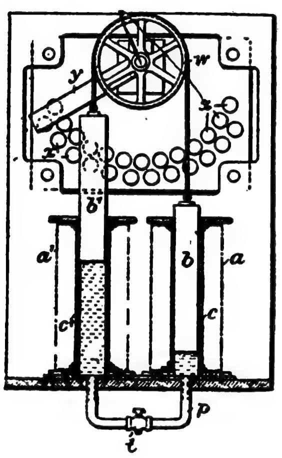

FIG. 4.—REGULATOR FOR SOLENOIDS.

damping or dash-pot effect of the arrangement may be increased or diminished by opening or closing the cock in the pipe connecting the two tubes in which the cores or solenoids move to a greater or less extent. *a* and a^1 are two solenoids which are designed to act against one another, and which respectively actuate the cores or plungers, *b* and b_1, which fit closely into the tubes, *c*, c^1, of brass, or other suitable material, on which the solenoids, *a* and a^1, are wound. The two cores, *b* and b^1, are fixedly attached to a pulley wheel, *w*, by a cord, this pulley wheel carrying an arm, *y*, which is adapted to move over the contacts, *x*, *x*, *x*, of the rheostat, and so introduce or withdraw resistance into or from the electric circuit which is to be controlled or regulated. The two tubes, *c* and c^1, are closed at their lower ends, and connected together at the bottom by the pipe, *p*, in which is the tap or cock, *t*, by means of which the flow of liquid through the said pipe, *p*, can be controlled. The operation of the apparatus is as follows: When either of the cores of the solenoids is attracted downwards, say, for example, the core, *b*, is being drawn down by the solenoid, *a*, the tap, *t*, being open, the oil or other liquid is forced through the pipe, *p*, and the tap, *t*, from the tube, *c*, into the tube, c^1, where it assists in raising the core, b^1. When the cores are moved in the opposite direction the liquid is, of course, forced from the tube, c^1, back into the tube, *c*. By opening or closing the tap, *t*, to a greater or less extent the rate of flow of the liquid can be controlled, and in this way the rapidity with which the cores move up and down under the action of the solenoids can be increased or diminished, while anything resembling violent or shock-producing movement can be completely prevented.

Lightning Arresters and Safety Devices.—The *Elektrotechnische Zeitschrift* contains an illustrated description of new safety devices made by a German cable works to prevent excessive rises of voltage. With horn lighting arresters an exact adjustment is difficult, since the arc is liable to fuse the ends of the electrodes where they are nearest to each other, and thus produce small points prolonging the terminals and thus diminishing the air-gap. The result is that the lightning arrester may begin to act slightly above the normal voltage. Moreover, with low voltages the horns must be adjusted in such close proximity that especially when they are used in the open air, water or snow may settle in the air-gap. To prevent these disadvantages a closely adjustable auxiliary arc-gap is provided, which begins to act at a voltage which may be predetermined with a high exactness. This auxiliary air-gap sends out radiation to the main air-gap between the horns and starts the main arc. Fig. 5 shows the arrangement. The main air-gap, *F*, is made larger than usual. The auxiliary air-gap, *f*, consists of a platinum point and a small platinum plate fixed at the earthed horn. The other horn (which is connected to the line, *L*) is connected with

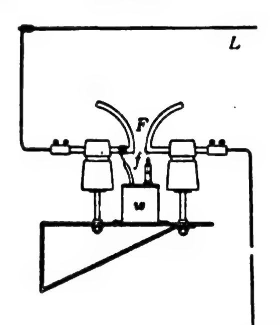

FIG. 5.—LIGHTNING ARRESTER.

the platinum point through a resistance, *w*. This resistance, *w*, is about 10,000 ohms per 1,000 volts; the object is to reduce the energy required for actuating the auxiliary air-gap to a small value. Another arrangement, which is used especially on mixed lines, consisting of overhead wires in connection with cables, is Zapf's drum. In order to protect the cable against dangerous overvoltages, this drum is provided at the point where the overhead line conects with the underground cable or at a point where the line is connected with machines to be protected; the purpose is that the fault shall be produced at this point. The drum consists of a short length of single conductor cable which is wound on an insulated drum and acts at the same time as a choking coil. The single windings of the earthed lead mantle of this cable are insulated against each other. In the conductor which earths the lead mantle a switch is provided which is opened after the accident has happened until repairs may be made. A third device described is adapted for cables only. It is similar in principle to Zapf's drum.

Some Recent Electrical Patents

Commutator Brush Holder.—Brush-holders and car couplings are patented in somewhat similar numbers, both subjects apparently having maximum attractiveness for persons of inventive minds. One of the most recent patents on brush-holders relates to the form illustrated by Fig. 1 and was issued to Messrs. William Heap and W. A. Barnes, of Bolton-le-Moors, England. The brush, *o*, is of special shape, as the illustration clearly shows, the enlarged head being adapted for clamping between a lug, *b*, which is integral with the pivoted arm, *a*, and a claw, *m'*, at the extremity of a sliding plate, *m*. This plate is drawn inward by the short end of the lever, *j*, which is pivoted to the main arm, *a*, under the influence of the helical spring, *k*. One end of this spring is seated on one leg of the pawl, *i*, which is pivoted on an arm,

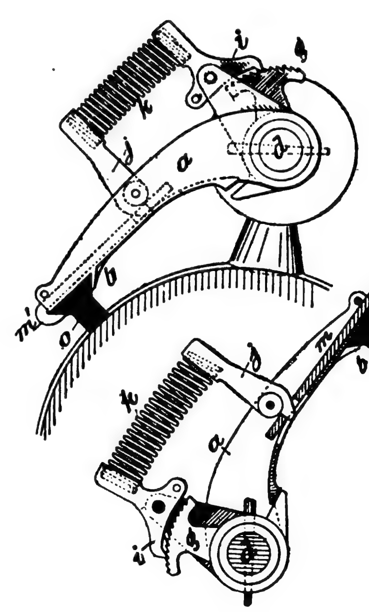

FIG. 1.—COMMUTATOR BRUSH HOLDER.

mounted on the stud, but immovably. The arm, may be adjusted about the stud (and held by the pawl, *i*) to give the desired compression to the spring, *k*, and the

latter, after drawing the claw, *m'*, solidly against the brush head, obviously presses the brush against the commutator, the arm,

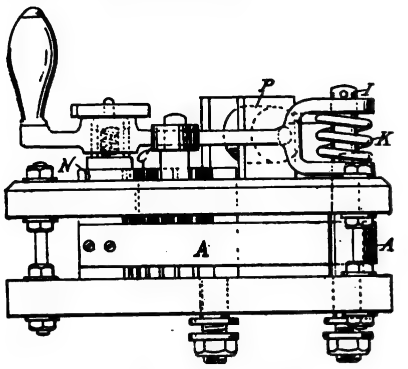

FIG. 2.—RHEOSTAT.

a, being mounted loosely on the brush-holder stud. Patent No. 781,650.

Rheostat.—The nuisance of making connection between the tap points of a rheostat conductor and the contact plates or buttons on the face plate is reduced to a very low degree in the construction patented by Mr. W. H. Powell, of East Orange, N. J., and illustrated by Figs. 2 and 3. The conductor is a continuous ribbon having its starting end attached to the central post, *B*, about which the ribbon is wound, the successive convolutions being, of course, insulated from each other. At suitable intervals the convolutions of the ribbon include in their embrace the successive contacts, *C*, with which the convolutions immediately next to them make electrical contact. The traveling brush, *N*, on the rheostat arm sweeps over the upper ends of the contact posts and cuts out the sections of the ribbon conductor in the usual manner. The conductor is enclosed in the box and the posts, *C*, protrude through the face plate to the proper height for contact with the traveling brush; this arrangement is clearly shown in Fig. 2, in which *K* is a spring for returning the rheostat arm to the "off" position when it is released by the magnet, *P*. The contacting part rests

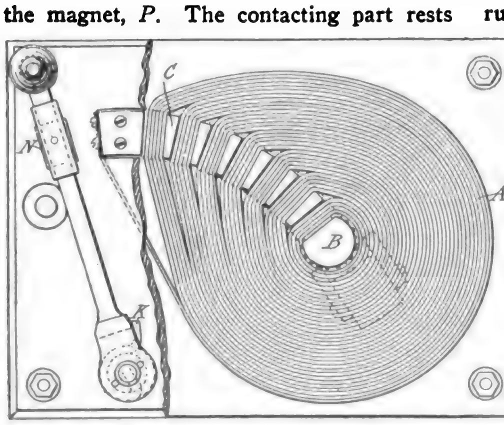

FIG. 3.—RHEOSTAT.

on the dead-block *N* which is attached to the upper slate. Patent No. 783,979.

CENTRAL STATION ENGINEERS.

VI.

Alonzo Gartley.

Alonzo Gartley was born at Cedar Falls, Iowa, on the eighteenth day of October, 1869. His early education was acquired in the public schools, and in 1886 he received an appointment as a naval cadet in the United States Naval Academy at Annapolis. In 1892 he resigned from the Naval Academy, and spent the following year with the Pennsylvania Iron Works Company as a designer of ice machinery. During the next seven years he was connected with the United Gas Improvement Company of Philadelphia as a constructing engineer and in the executive department. In 1900 he became general manager of the Hawaiian Electric Company, Ltd., of Honolulu, which office he still retains. The growth of the Hawaiian Electric Company

ALONZO GARTLEY.

since Mr. Gartley's connection with it is interesting. When he took charge in February, 1900, the plant carried a load of 390 kilowatts, 300 being in 110-volt alternating current and 90 in 120-volt direct current. There were then installed 10,500 16-c.p. incandescent lamps and about 100 horse-power in direct-current motors and no arc lamps. At the close of 1904 there were connected in circuit 31,000 16-c.p. incandescent lamps, over 600 horse-power in 500-volt direct-current motors and 220 arc lamps, and this in spite of the fact that the population, especially among the whites, had very materially decreased. Over 85 per cent. of the business is done with the white population, of whom there are about 7000 and the balance is divided among Portuguese, Japanese, Chinese, Porto Ricans, Koreans, natives and other nationalities, numbering about 33,000. Mr. Gartley is an associate member of the American Institute of Electrical Engineers, and a member of the United States Naval Institute, American Gas Light Association, and the Pacific Coast Gas Association.

TESTS OF TANTALUM LAMPS.

There appeared in the March number of the American Electrician a short description on the new tantalum incandescent lamp, recently developed by the German firm of Siemens & Halske, of Berlin. Since then Messrs. A. E. Kennelly and S. E. Whiting have made some tests on a batch of ten, the results of which are quite interesting. These lamps were all alike and of the type shown in connection with the article published last month. For purposes of comparison a 3.1-watt, 120-volt, 16-c.p. Edison carbon filament incandescent lamp was taken at random from a number of similar lamps and used. The tantalum lamps were 110-volt lamps having a normal horizontal candle-power of 25 hefner units. All of the lamps, including the carbon lamp, had frosted globes. The tantalum lamp became appreciably luminous at a terminal e.m.f. of 9.5 volts, or about 9 per cent of its normal working voltage. The carbon filament became luminous at 24 volts, or about 20 per cent of its normal voltage. Thus a tantalum filament will begin to glow at a much lower voltage than the corresponding carbon filament. This may prove a useful property in testing and the like. The horizontal candle-power of the tantalum lamp is markedly greater than that of the carbon lamp. The luminous efficiency, or candles per watt, of the tantalum lamp is also markedly greater than that of the carbon lamp tested. Thus at 110 volts the tantalum lamp consumed 2.2 watts per candle, while at 120 volts, the normal for the carbon lamp, the latter consumed 4.3 watts per candle. The normal efficiency of the frosted tantalum lamp was, therefore, nearly double that of the carbon lamp. A small change of voltage produced a somewhat larger change of the candle-power in the tantalum lamp than in the carbon lamp. Thus an increase of 1 per cent. in normal voltage produced 0.7 candle increase with the tantalum lamp, and 0.6 candle with the carbon lamp. The lamps were, therefore, nearly alike in the increase of candle-power for a given small increase in voltage, but as the relative behavior in this respect would change appreciably with a shifting of the chosen working voltages, not much stress can be laid on this comparison. Since, however, the candle-power of the tantalum lamp was considerably greater than that of the carbon lamp, it

is evident that if equal small increase in voltage produces equal increase in candle-power, the percentage of increase will be markedly less in the tantalum lamp. With frosted globes the change in horizontal candle-power with change of azimuth was negligible in the tantalum lamp. This would be substantially true in an unfrosted lamp, owing to the cylindrical disposition of the filament. In the observed distribution of a tantalum lamp in a vertical plane, at the tip the candle-power falls to about 6, the horizontal value being 18.6. The mean spherical candle-power was 13.55, which gives a spherical conversion factor of 0.73. The vertical distribution of the tantalum lamp is nearly the same as that of the common type of carbon filament lamp. The accompanying table shows a comparison of the ten tantalum filament lamps is re-

Lamp number.	Power, watts.	Horizontal candles.	Specific Consumption, watts per candle.
1	39.35	18.45	2.13
2	40.56	18.60	2.17
3	40.20	19.80	2.06
4	40.98	19.20	2.13
5	40.56	20.60	1.97
6	39.68	18.96	2.09
7	40.30	18.80	2.14
8	40.40	19.90	2.03
9	39.55	18.65	2.12
10	40.32	19.05	2.12
Mean	40.19	19.20	2.10

gard to uniformity of candle-power and consumption at the nominal voltage, 110.

NOTES.

Same Old Story; Nothing New.—An appropriation of $600,000 has been made by the Board of Aldermen of New York for the purchase of a site for a municipal electric lighting plant—the site which was to "cost the city not a penny," according to the alleged arguments of the municipal ownership advocates. It is a safe prediction that after the plant is built the feed-water for the boilers, which would otherwise be used and paid for by the Edison Company, will "cost the city not a penny"; also the water-front privileges, which would otherwise command an attractive income.

The Electric Lighting Engineers of New England.—At the annual meeting of the Association of Electric Lighting Engineers of New England, held on March 15, at Boston, the following officers were elected for the ensuing year: J. W. Lawles, of Boston, president (re-elected); W. I. Barnes, of Providence, R. I., vice-president; C. R. Brown, of Boston, secretary and treasurer (re-elected). The new members of the Board of Directors are A. E. Bliss, of Malden; W. R. Eaton, of Cambridge, and Geo. R. Stetson, of New Bedford. Messrs. W. C Woodward, of Providence; W. E. Holmes, of Newton, and E. H. Mather, of Portland, were re-elected to the board.

Entertainment Features of the Electric Light Convention.—The delegates to the convention of the National Electric Light Association, which meets in Denver the week of June 6, will be treated to a "broncho-busting" contest. The committee is making an effort to secure enough "outlaws" from the big ranches of Colorado and Wyoming to test the riding of the cowboys to the limit. The most expert riders in the West will be seen in the contest and people who have only read of the real Western cowboy will have a chance to see him in one of the most exciting features of his life. All of the committees planning the work of the convention give encouraging reports. They have set out to make the convention the best in the history of the association and the outlook for success is most promising.

An Important Water Power Project.—A company has been organized to develop an attractive water power site in Washington. It is proposed to take a body of water out of the Columbia River, in sufficient quantity to irrigate 8000 acres of land by gravitation and to furnish power to operate a hydraulic-electric plant large enough to supply a number of lumber and flour mills as well as electric railways and pumping plants for the irrigation of three tracts of fine agricultural lands. The first tract contains 70,000 acres, the second, 160,000 acres, the third, 184,000 acres. There is a fall of 78 feet from the head of the rapids to the foot, eleven miles distant. It is proposed to cut a canal 20 feet wide at the bottom and 40 feet at the top, for a distance of three miles from the head of the rapids, to bring the water out on level ground. The depth at the deepest place will be 30 feet. In building this waterway the lateral ditches and reservoir on the tract of 70,000 acres will be built at the same time work is being done on the power canal.

The engineers' estimated cost of this project is $687,000. The promoters desire information from manufacturers as to the best and latest types of machinery for this kind of work. Fuller particulars are obtainable from Mr. M. D. Kelley, post office box 384, Seattle, Wash.

Proposed Long-Distance Electric Railway or Germany.—As an indirect consequence of the famous Marienfelde-Zossen high-speed trials, a large electric railway scheme is planned by a Berlin company, which intends connecting the cities of Cologne and Düsseldorf, about 40 km. apart, by a high-speed electric railway of standard gauge. This railway, the cost of which is estimated at about 20,000,000 marks, would be designed partly after the plans of the Cologne-Bonn electric railway, which is nearing completion. The German Government is said to have abandoned for the present any idea of taking in hand the installation of electric railways, as was hoped after the Zossen trials.

Another long-distance railway is being planned by the Hamburg County Council, it being contemplated to connect Blakenese with Altona, Hamburg and Ohlsdorf by an electric railway. Part of this line is to be of special construction, and the necessary powers have been granted by the Hamburg Senate and County Council. As soon as the Prussian Diet has ratified the construction of the Prussian section of this railway, a special power station will be erected near Altona, the cost being shared by the two States of Hamburg and Prussia. The projected railway is mainly intended for securing a more rapid and frequent connection between Hamburg and the neighboring towns.

The Moutiers-Lyons Electric Power Transmission Plant.—A large power transmission plant is being installed between Moutiers and Lyons, France, by the Société Grenobloise de Force et de Lumiére, which after considering a number of projects, decided on adopting constant current transmission, at 50,000 volts. Thury electrical apparatus and material will be used in the generating and the receiving stations. The transmission line will be about 112 miles long, and 6300 horse-power is to be transmitted from Moutiers to Lyons. Part of this power is to feed by direct current of 600 volts the Lyons tramway system, while the remainder is intended to supplement the existing three-phase system of 25,000 volts constant potential. Reversible motor-generators will be provided, so that in case of necessity, the three-phase system will be able to help out the direct current system, or *vice-versa*. The primary line will enter Lyons by underground cables several miles in length, carrying direct current of upwards of 50,000 volts. This has been rendered possible by the absence of induction, resonance, etc.

The Moutiers generating station will contain at the beginning four units of 1600 horse-power each, consisting of a turbine driving two double dynamos. There will thus be eight double dynamos each capable of delivering 7200 volts and 75 amperes. The dynamos are series-wound and self-excited; they have 6 poles and run at variable speeds according to the voltage requirements, their maximum speed being 300 r.p.m. The power station has been made as simple as possible, there being no switchboard and no electrical regulating apparatus except governors, which act directly on the gates of the turbines. Each dynamo is equipped with a simple circuit-breaker, a voltmeter and an amperemeter. There is at the starting point of the line a lightning arrester equipment.

At Lyons the primary direct current is converted in a sub-station into low-tension direct current (600 volts) to be used for traction purposes. The converters are of 500 kilowatts capacity each at 428 r.p.m., and will run at constant speed. In a second sub-station there will be installed at the beginning two 500-kw. motor-generator sets, each of which comprises a constant-current machine of 75 amperes and 7640 volts maximum, coupled to a three-phase synchronous alternating-current machine. Each of these can act as either a generator or a motor. All the direct-current machinery has been so arranged as to be changed over later to 150 amperes capacity, a considerable increase in the transmitted power being anticipated.

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CONTENTS.

Increasing Central Station Business.

The article on this subject, which appears elsewhere in this number, we cordially commend to the attention of central station managers, particularly those in charge of stations of medium size—between 2500 and 10,000 kilowatts maximum output ability, for example. One of the prime errors of judgment on the part of many managers of such plants is the failure to base all their calculations and plans on the fact that they have a commodity to sell which will not attract customers in many cases without some effort on the part of the seller. The men in charge of the larger stations of this country realized this some time ago, and are now carrying out well-defined policies of aggression. The Edison Companies in the largest three cities, for example, issue monthly bulletins containing convincing arguments; some of the smaller companies send out catchy circulars and employ a "follow-up" system. One progressive station manager has enunciated the doctrine that the way to get and hold business is to give the very best service that is possible and to sell fittings and supplies to your customers at almost cost. This undoubtedly goes a long way toward getting all the business that a community can give, but while it is a most sensible policy it is a limited one. There are always people who need more or less demonstration of the advantages of electric light and power, and who probably never would voluntarily inquire into the matter, and the day is long past when any manager can afford to sit down and wait for eligible customers to arrive automatically at the stage of feeling impelled to patronize the company whether or no. Even in the smaller cities where there is no competition the station output can always be judiciously increased by the proper sort of managerial policy and energy. Mr. Knowlton's article is peculiarly timely, and should be of much value to those for whom it is written.

Modern Arc Lamps.

On another page we print a résumé of present practice in arc lamp construction which can scarcely fail to interest almost every one connected in any way with the arc lighting industry. It is particularly interesting to compare, in the mind's eye, the modern types of lamp described in this article with those which were regarded ten years ago as models of perfection. All central station men of sufficiently long experience remember well enough the aggregations of complex mechanism which tried their souls in the early nineties—the "clucking" lamp with separate lift and feed magnets, the "open circuit" lamp which was damaged with distracting regularity by efforts on the part of the trimmer to pull the upper carbon holder down without releasing the clutch, and the first "constant-potential" lamp, supposed to work two in series on a 110-volt circuit, but which in reality "bucked" and "robbed" its mate so assiduously that it was regarded as a miracle when both lamps actually burned at equal brilliancy for even a few minutes. These are all now in the category with the bipolar Edison dynamo (though they never gave anything like as good service) and the notorious "Underwriters'" insulation for line-wires.

The modern arc lamp is really a marvel of mechanical development. It usually comprises merely the carbon mounts, a pair of magnet coils and a rudimentary clutch actuated through the medium of one or two links. This is especially true of constant-potential lamps; the lamps for series circuits are almost necessarily differential as to the electromagnetic action. All of them are practically as reliable as the proverbial grindstone, and when they receive anything like reasonable attention will give satisfactory service for years upon years. In the article referred to above, only those lamps which are typical of different classes of construction have been described; space limitations preclude the description of all the different makes on the market. But the reader who lacks familiarity with the details of arc lamp construction and adjustment will find practically all the information there that is necessary to a fundamental working knowledge of any American arc lamp, after locating the class in which it belongs.

Why Not Automatic Synchronizing?

The difficulty of bringing an alternating-current generator or a rotary converter into synchronism with the line and throwing it in just at the moment of exact synchronism is so familiar to every switchboard attendant who has it to do that no discussion of that particular point is necessary. Of course, it is done every day of the year, and usually without absolute "misfires" when the attendant is highly practiced, and has the "knack." But there would seem to be a good opportunity for someone to provide an automatic synchronizer which would perform the feat of coupling machines at the psychological moment and eliminate the questions of personal judgment and experience. The combination of a phase indicator and a mech-

anism the reverse of an automatic circuit-breaker to be controlled by the indicator does not appear to present any serious difficulties of construction, and the application of such a device would produce highly beneficial results in the wear and tear of machinery, not to mention the nerves of the men whom it would relieve of the task of paralleling.

Motor-Driven Wood-Working Tools.

In our Foreign Contemporaries Department this month we print the results of a series of tests made with motor-driven wood-working machinery which are of much value as far as they reach. Unfortunately, some important particulars are missing from a few of the tests, but as the matter is taken from a European paper the deficiencies could not be remedied. Among the most noticeable of those features which would scarcely have been anticipated, at least by anyone not thoroughly experienced in the details of operating wood-working machinery, is the great difference between the motor current while running idle with a given size of cutting tool and that required under the same conditions with a larger tool. For example, in the tests of a motor-driven circular saw, the motor took 4¼ amperes running light with a 24-inch saw and 6 amperes running light with a 36-inch saw. Again, the tests of the vertical-spindle moulding machine showed 5 amperes with a small cutting head and 7½ amperes with a 3-inch head, running idle in both cases. Comparing these figures with those taken when the tools were cutting, it is evident that the power taken by the machine running idle is a very large proportion of the power required while at work. This is not surprising, of course, in view of the enormous spindle speeds at which these machines run, and similar indications have been obtained by tests in this country; but it seems rather out of proportion to find the friction load going up in direct ratio to the diameter of a circular saw or a moulding cutter head.

Some tests of motor-driven wood planers recorded in this country show such figures as 4.4 electrical horse-power running idle, and just twice that amount taking a cut ⅛ inch deep and 10 inches wide with a feed of 12 feet per minute; 5 electrical horse-power running idle and 18 horse-power taking a cut ⅛ inch deep and 9 inches wide at 25 feet per minute, and so on. Tests of a circular saw 36 inches in diameter running light at 1,200 r.p.m. showed 6.4 electrical horse-power, while another saw 33 inches in diameter at the same speed took 6 horse-power running light. This apparent inconsistency might be explained by easily conceivable circumstances, but imagination balks at any attempt to conceive a reason for a friction load varying in direct proportion to the diameter of the saw.

Inductance and Reactance.

Most electrical students in their earlier attempts to master the intricacies of alternating-current theory and practice become confused by the apparent similarity of the terms "reactance" and "inductance," and are inclined to regard them as practically synonymous, like "period" and "cycle." The two terms have very different meanings, and the distinction between them should be thoroughly understood and observed. Any loop or coiled conductor possesses the property of inductance—that is, the property of inducing a counter e.m.f. in itself when a current is suddenly passed through it, or when an existing current is quickly varied in strength or cut off. The inductance of such a conductor depends entirely upon mechanical conditions; it is proportional to the square of the number of turns, in a coil; it is proportional to the area of the space surrounded by a coil or embraced by a loop; it is proportional to the magnetic conductance (permeance) of the material surrounded by a coil or embraced by a loop. It is entirely independent of the electrical conductivity of the wire in the loop or coil, and consequently independent of the total resistance; it is also independent of the strength, characteristic, variation and duration of any current that may be sent through the loop or coil.

Reactance may be due either to inductance or to electrostatic capacity; in the former case it is termed "inductive reactance," in the latter, "capacity reactance" or "condensive reactance." A coil or loop possessing a certain amount of inductance (measured in parts of a henry) will have exactly the same reactance as another coil or loop having as much capacity (in parts of a farad) as the first coil had inductance, if supplied with current under exactly the same conditions; but its reactance will have a different characteristic. Inductance chokes back the current flow in the circuit, while condensance or electrostatic capacity tends to increase it. Consequently, if a circuit has exactly as much inductance, in parts of a henry, as it has capacity, in parts of a farad, the two neutralize each other and the current will flow as though the circuit had neither inductance nor capacity.

Reactance is directly proportional to (1) the rate of change in the strength of the current, and (2) either the inductance of the circuit or the *reciprocal* of its capacity, according to whether it is an inductive or a condensive circuit. If both inductance and capacity are in the circuit and they do not equalize each other, the reactance will be proportional to the difference between the two. Without any current flowing, there is absolutely no reactance; and if there be a current in the circuit but its strength is not changed, there is no reactance. The counter e.m.f. produced by either inductance or capacity in a circuit is equal to the reactance multiplied by the geometrical average of the current strength.

The Control of Railway Motors.

The appliances for controlling railway car motors have undergone a gratifying improvement during the past five or six years, especially as regards motors on electrically propelled trains, such as those of the elevated systems. There is still lacking, however, a feature which has always seemed to us to be of importance secondary only to that of safety (which involves reliability, of course), namely, the removal of the rate of acceleration from the control of the motorman. Appliances have been worked out by means of which the motors may be started and brought up to the speed corresponding to the position of the controller handle at a rate of acceleration entirely independent of the movement of th handle, but standing passengers continue, nevertheless, to be jerked about and thrown into all sorts of grotesque attitudes whenever a motor-driven car or train is started by a motorman who feels under the necessity of "making up time." The same thing occurs when such a car or train is brought to a stop, but this is vastly more difficult to avoid; variations in acceleration due to differences in load conditions would mean merely slight losses or gains in schedule time which would probably neutralize each other in the course of a complete trip, but similar variations in stopping might cause disaster, and would almost invariably result in much inconvenience. Still, we are unable to convince ourselves that the solution of both ends of the problem is beyond the reach of modern engineers. Possibly it reduces to a question of commercial expediency, but that is a most uncomfortable hypothesis.

DESIGN AND CONSTRUCTION OF SMALL DYNAMOS AND MOTORS.

BY CECIL P. POOLE.

The Armature Winding.

Having determined the proper size for the armature conductors, the number of coils to go on the armature and the number of turns per coil, as instructed in a previous article, it remains to actually put the winding on the core and in such manner as to use the minimum amount of copper and to insure reliability. If the builder has had experience in practical armature winding, the best way to put on the winding of a two-pole machine is to follow out the old-fashioned "spiral" method used years ago on smooth-core armatures; if he is inexperienced, then the less symmetrical method of winding known as the "skip" will come easier. The spiral winding is put on as follows, assuming that the core has 32 slots and the same number of coils (two half-coils, one on top of the other, in each slot):

The first coil is wound directly into slots 1 and 15 (see Fig. 1); the next, into slots 2 and 16; the next into slots 3 and 17, and so on until the whole 32 coils are in place. The inexperienced amateur will find it almost impossible to put the winding on in this fashion without having it hump up to an inadmissible extent on the core heads. He will succeed much better with the "skip" winding. In using this type, it is only necessary to remember that the coils are put on in pairs, the two coils of each pair being parallel to each other across the heads; that the coils of each pair lie on each side of two teeth, which are precisely opposite each other diametrically; that each successive pair of coils must lie as far away as possible from the pair last put on the core, and that every coil must be put on exactly like every other coil. For example, suppose that a 32-coil armature is to be wound. The first pair of coils will go into slots 1 and 16 and slots 17 and 32; that is to say, the first coil will be wound into slots 1 and 16, laying the first wire into slot 1, from front to back, carrying it across the back head, bringing it forward in slot 16, and so on, according to the number of turns in the coil; then the armature must be turned through half a revolution in the "stocks," and the second coil wound into slots 17 and 32. The next pair of coils would go in slots 9 and 24 and slots 25 and 8, at right angles to the first pair. The next pair could go either in slots 3-18 and 19-2, or slots 31-14 and 15-30, either set of slots being as far away from the pair of coils last put on as possible. Following out this scheme of winding, the builder will usually be able to keep the heads down fairly well. Another point to be kept in mind is that the terminals of each coil must be located at the opposite side of the front head from the terminals of the other coil of the pair. Thus the terminals of the first coil, in the case just assumed, would be twisted together at slot No. 1, while those of the second coil would be located at slot 17—exactly opposite diametrically. Again the "starting" end, or the end which is made fast during the winding of a coil, should be knotted or otherwise marked for identification and the final end or terminal left unmarked.

Before putting on a bipolar winding, the core must be thoroughly insulated. The slots should be protected by troughs of varnished linen and strips of mica and the heads by discs of varnished linen. A good plan to follow is to varnish two discs of

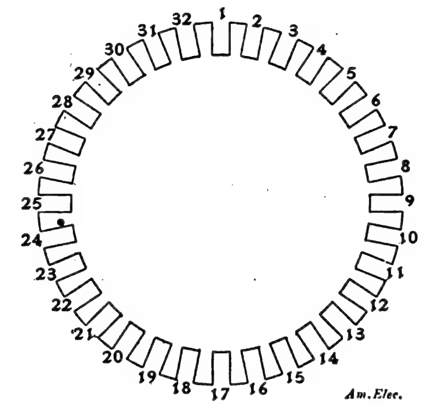


FIG. 1.

linen of sufficiently large diameter to cover the entire armature head, teeth and all, and paste them on the heads with the varnish. When they have dried thoroughly, slits corresponding to the edges of the core slots should be cut in the edges of the discs and the little flaps opposite the core slots bent down into the slots and pasted to their floors. Then a trough of varnished linen should be pasted into each slot; the ends of each trough should protrude ¼ inch or so beyond the core, slits should be cut in the projecting ends where they are creased to fit the slot corners, and the three flaps thus produced should be turned back and pasted against the ends of the core and teeth with varnish. Fig. 2 shows one of these troughs with the ends slitted as described; the dotted lines *s, s,* indicate the lines of creasing to correspond to the slot corners and the dotted lines, *c, c,* indicate where the core stops and the flaps are to be bent back against it.

After one set of troughs has been put in place, another linen disc should be pasted

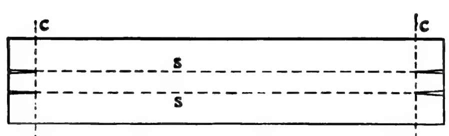


FIG. 2.

on each end of the core slitted at the edge, and the flap pasted down in the slots, like the first pair; then another set of troughs should be put in the slots; still another disc should be pasted on each end, and finally a third set of linen slot troughs. The linen should be thin, but very closely woven; the three thicknesses, varnished, should not exceed 40 mils. After the slots and core heads have been covered as described, the armature core should be baked in an oven at 120° to 130° Fahrenheit until the linen discs and troughs are bone dry; then the winding may be put on.

In winding the coils into the slots, a single thickness of varnished linen should be laid over each pair of coils at the points where the next pair will cross them, at both ends of the core. When the winding is all on, it should be thoroughly varnished wherever a brush will reach, but no varnish should be "slopped" on; it is usually best to dip the complete armature in a pan of rather thin varnish, wiping off every vestige of varnish from the shaft as soon as the armature comes out of the pan. Then the armature must be baked, as in the case of the unwound core. After the winding has been connected up to the commutator, it is a good plan to bake it again, this time by means of current sent through the winding, the armature being put in an unheated oven during the process. The current may be put through the winding by binding two contact plates to two diametrically opposite commutator segments with stout cord, and connecting the supply circuit to the contact plates. The current should not be more than 50 per cent. in excess of the rated full-load current of the armature, and the armature should be supported by blocks under the ends of the shaft and turned halfway over at intervals of fifteen or twenty minutes during the baking.

The winding of a multipolar armature is a much easier job than that of a bipolar machine. The coils are not wound into the core slots, but on two pins located at the proper distance apart; they are then pulled into shape to fit the core. The core slots must be insulated by troughs, but a single layer of pressboard 15 mils thick is ample. The troughs should be varnished, and the ends should project and be slitted and turned back as described in the case of the linen troughs of the bipolar armature. The barrels or flanges on the armature core end-plates must be thoroughly insulated, because the coils project beyond the core heads and are bound down on these flanges. Two layers of varnished linen will be sufficient; but these must be put on carefully so that no part of the periphery of the barrel is unprotected. The unwound core need not be baked.

The coils are wound, one at a time, on two pins, the distance apart of which is ascertainable by means of Rule XVII. The distance given by the rule is that from the broken line, *B*, Fig. 3, to the center of the nearest pin, indicated by the symbol, *Cp*. The sketch illustrates a three-turn coil on the winding pins ready to be tied and removed. The starting end is marked *s*, and the finishing end *f*; the successive turns are wound on top of each other, and in order to make the wire build up this way, the winding pins will have to be set into a board of sufficient width and length to give the wires support on the side, and large washers put on the ends of the pins and secured by nuts, as indicated in Fig. 4. The board carrying the pins must be mounted on a spindle, somewhat as indicated in the sketch, so that the complete winding frame can be re-

volved about its center (in a lathe, or in a pair of journals set on blocks).

After a coil is wound on the pins, the turns must be tied together temporarily with coarse linen thread; one tie thread should be used at the loop farthest from the free ends, one on each stretch of the coil, halfway between the points indicated

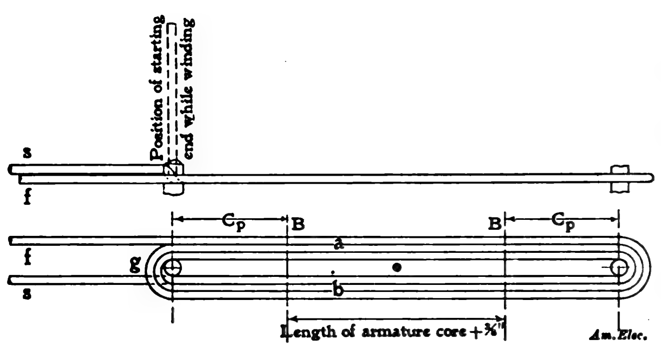


FIG. 3.

by the lines, B, B, and two at the loop, g, nearest the free ends, as near the pin as possible, so as to keep both of the ends in place. Then the nuts and washers are to be removed, the coil taken off the pins and hung on a peg until all the coils have been wound. When they are all wound they should be pulled out into the shape shown in Fig. 5, the distance between the two stretches, a, b, being just far enough to permit the coil to be pulled into the proper slots in the armature core. Before spreading the coil, each stretch of it should be securely clamped between the lines, B, B, and at the end loops; the distance between the lines, B, B, must be equal to the length of the armature core + 3/8 inch, and in order to make the coils all alike it is advisable to make the clamp jaws exactly this length. If two or more coils are to go in a slot side by side, they should be tied together as though they were a single coil, and spread. Each stretch of each coil, however, should be wrapped in a trough of pressboard 0.01

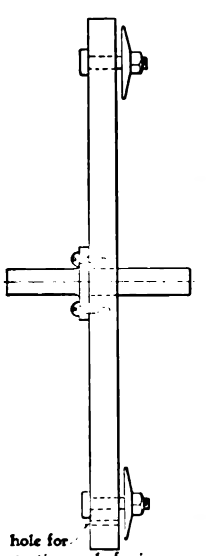


FIG. 4.

inch thick and the full length of the armature core before tying together. Fig. 5 shows a single coil spread into shape and with the terminals brought out to suit a two-path or wave-connected winding. When

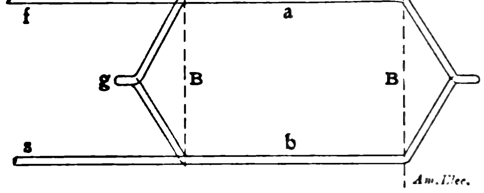


FIG. 5.

a lap winding is used, the terminals must be brought out at the loop, g, instead of at the bends.

After spreading, the coil, or group of coils if there be more than one, must be given a single wrapping of oiled linen tape 0.007 inch thick, each convolution of the tape lapping just half of the last convolution, as indicated roughly by Fig. 6. The taping must cover the entire coil, loops and all. Fig. 7 is a cross-section through an armature slot containing two four-turn coils side by side and insulated in the manner just described. After taping, the coils should be dipped in thin insulating varnish and allowed to become almost dry in air; when the varnish begins to set they should be put in place on the core. Then three or four bindings of twine should be put around the core and the projecting parts of the coils, and the armature put in the oven and baked until the accessible parts of the winding are perfectly dry.

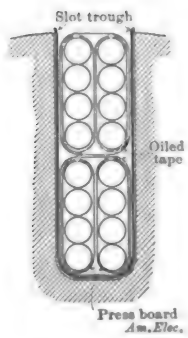


FIG. 7.

Rule XVII.—The winding pins for barrel-type armature coils must be equal to the armature core length plus 3/8 inch plus twice Cp. *To ascertain the distance,* Cp, *add the diameter of the armature core to the diameter of the tooth-root circle and multiply their sum by 0.2 for a four-pole machine or by 0.14 for a six-pole machine.*

The commutator should then be put on the shaft and the winding connected up to it. Each coil, as its first terminal is put in place in the commutator lug, must be tested for ground on the core by means of 500-volt direct-current leads from a circuit, both of the leads being fused lightly and no lamps being inserted. Before each test, care should be taken that none of the terminals of the coils is in contact with any part of the core, shaft, commutator or any

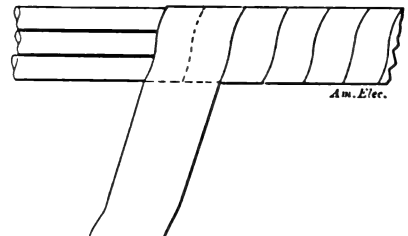


FIG. 6.

other terminal. In order to identify the second terminal of each coil, all of the first terminals having been put in their respective commutator lugs, a pair of leads from a 110-volt circuit, with an incandescent lamp inserted in one of them, should be used. After all the coils have been connected up, the winding must be again tested for grounds, and if clear, the armature and commutator must be baked for four or five hours at a temperature of about 120 Fahrenheit.

DISEASES OF ELECTRICAL MACHINERY.

BY F. B. CROCKER AND S. S. WHEELER.

Heating in Generators or Motors.

Methods of Locating and Measuring—The degree of heat that is injurious to any part of a generator or motor may be roughly determined by feeling the various parts. If the heat is bearable it is entirely harmless; but if the heat is unbearable for more than a second the safe limit of temperature has been passed, and it should be reduced in some of the ways that are given below. If the heat has become so great as to produce an odor or smoke, the safe limit has been far exceeded, and the current should be shut off and the machine stopped immediately, as this indicates a serious trouble, such as a short-circuited coil or a hot bearing. The machine should hot be started again until the cause of the trouble has been found and positively overcome. Of course, neither water nor ice should ever be used to cool electrical machinery, except possibly the bearings of large machines, where it can be applied without danger of wetting the other parts. .

The rough determination of temperature by feeling may answer in ordinary cases, but the sensitiveness of the hand varies, and it makes a great difference whether the surface is a good or bad conductor of heat. The back of the hand is more sensitive and less variable than the palm for this test. For more accurate results a thermometer should be applied and covered with a small pad of cloth or cotton waste. A standard form consists of waste contained in a shallow circular box about 1½ inches in diameter. The surface temperature thus determined should not rise more than 40 degs. C. above that of the room for any part of an electrical machine, including the bearings, but excepting commutators, collecting rings and brushes, for which 55 degs. C. rise is allowed.

The best method of determining temperature rise is by measuring the increase of resistance, but evidently it can be applied only to the coils or other electrical conductors not including the commutator. The temperature rise

$$\theta = (238.1 + t)\left(\frac{R_{t+\theta}}{R_t}\right) \text{ in which } R^{t} + \theta$$

is the resistance at the final temperature $t° + \theta°$ C., and R_t is the resistance at the room temperature $t°$ C., the standard value for which is 25 degs. C. This matter is stated fully in the *Transactions* of the Amer. Inst. Elect. Eng., Vol. XIX, p. 1075, June, 1902.

It is very important to locate the heat in the exact part in which it is produced. It

is a common mistake to suppose that any part of a machine found to be hot is the seat of the trouble. A hot bearing may cause the armature or commutator to heat, or vice versa. All parts of the machine should be tested to find which is the hottest, since heat generated in one part is rapidly diffused. It is more definite to start with the whole machine cool, after it has stood without current for several hours or over night. Any serious trouble from heating is usually perceptible after a run of a few minutes at full speed with the field magnets excited.

B. Heating of Commutator and Brushes.

This trouble, like sparking, may occur in direct-current machines, and in the types of alternating-current apparatus that have commutators already enumerated under the head of "Sparking."

Cause 1.—Heat spread from another part of machine.

Symptom.—Start with the machine cool and run for a short time, so that heat will not have time to spread. The real seat of the trouble is in the part that heats first.

Remedy.—(See Heating of Armature, Fields or Bearings.)

Cause 2.—Sparking.—Any of the causes of sparking will cause heating, which may be slight or serious.

Symptom and *Remedy.*—(See "Sparking.")

Cause 3.—Tendency to spark or incipient sparking hardly visible. Sometimes before sparking appears, serious heating may be produced by one or more of the causes of sparking.

Symptom.—The heating is reduced by applying the principal remedies for sparking, such as slightly shifting or more carefully fitting the brushes. Fine sparks may be seen by sighting in exact line with the surface of contact between the commutator and brushes. Incipient sparking due to excessive inductance in each armature section can be corrected only by reconstruction. When caused by a weak magnetic field it may be cured as explained under "Sparking," Cause 8.

Remedy.—(See "Sparking.")—Apply the remedies with extra care.

Cause 4.—Overheated commutator will decompose carbon brush and cover the commutator with a black film, which offers resistance and aggravates the heat.

Symptom.—Commutator covered with dark coating; commutator brushes and holders show signs of abnormal heat.

Remedy.—Commutator and brushes should be thoroughly cleaned, and the latter carefully fitted to make good contact at the proper points. (See "Sparking," Causes 2, 3 and 4.) It may be necessary to substitute a different kind of carbon brush..

Cause 5.—Bad connections in brush-holder, cable, etc.

Symptom.—Holder, cable, etc., are abnormally high in resistance, unusual resistance may be found in these parts by "drop method."

Remedy.—Improve the connections.

Cause 6.—Arcing or short-circuit in commutator across the mica, or across the insulation between bars or nuts.

Symptom.—Burned spot between parts; arc or spark appears in the insulation when the machine is operating.

Remedy.—Pick out the charred particles, take commutator apart and repair or put on new commutator.

Cause 7.—Carbon brushes heated by the current.

Carbon brushes require less attention than copper, because they do not cut the commutator, and their higher specific resistance usually reduces sparking, but it may also cause them to heat more than copper brushes.

Symptom.—Brushes hotter than other parts.

Remedy.—Use higher conductivity carbon. Let the brush-holder grip brush closer to commutator so as to reduce the length of brush through which the current has to pass. Reinforce the brush with copper gauze, sheet copper, or wires run through it, or use some form of the combined metal and carbon brushes that are on the market. Use larger brushes or a greater number of them so that the current density does not exceed 30 or 40 amperes per square inch of contact area.

C. Heating of Armature.

This trouble, excepting Causes 6 and 8, may occur in any direct or alternating-current machine, whether generator or motor. The two causes excepted may give trouble in direct but not in alternating-current machines.

Cause 1.—Excessive current in armature coils.—Symptom and Remedy the same as "Sparking," Cause 1.

Cause 2.—Short circuited armature coils. —Symptom and Remedy the same as "Sparking," Cause 5. See also Cause 7.

Cause 3.—Moisture in armature coils.

Symptom.—Armature requires considerable power to run free. Armature steams when hot, or feels moist. This is really a special case of Cause 2, as moisture has the effect of short-circuiting the coils through the insulation. Measure insulation of armature, which would be much lowered by moisture.

Remedy.—The armature should be baked for several hours in an oven or other place sufficiently warm to drive out the moisture, but not hot enough to run any risk of injuring the insulation. A convenient and safe method to dry an armature (or field winding) is to pass through it a current which should be regulated to be about three-quarters of the rated current, the armature being held still or turned over occasionally.

Cause 4.—Eddy currents in armature core.

Symptom.—Iron of armature core hotter than coils after a short run, and considerable power required to run armature when field is magnetized and there is no load on armature. This may be distinguished from Cause 2, by absence of sparking and absence of excessive heat in a particular coil or coils after a short run.

Remedy.—Armature core should be laminated more perfectly, which is a matter of first construction.

Cause 5.—Eddy currents in armature conductors.

Symptom.—The same as Cause 4, except that armature conductors are hotter than core even without any load.

Remedy.—This trouble is due to a difference in the e.m.f. generated on the two sides of each armature conductor. It is overcome by reducing the thickness of the conductors or by splitting them up into a number of strips or strands, which should be twisted to equalize the effects. Rounding or beveling off the edges of the pole pieces will also reduce the trouble. The usual and most effective cure is to put the armature inductors in slots or perforations in the armature core.

Cause 6.—One or more reversed coils in one part of armature, which will cause a local current to circulate around a direct-current armature.

The armature coils of an alternating-current generator or synchronous motor being usually arranged in series, the only effect of a reversed coil is to reduce the e.m.f. corresponding to a loss of two coils. It does not cause short-circuiting or heating.

Symptom.—Excessive current in a direct-current motor running free, or excessive power required to drive an alternator without load. In a direct-current motor running with considerable load, the half of the armature containing the reversed coil is heated more than the other (the opposite being true of a generator), but no individual coil is abnormally heated. If a moderate current is applied to each coil in succession by touching wires to each two adjacent commutator bars and a compass needle is held over the corresponding coils the latter will behave differently when the reversd coil is reached.

Remedy.—Reconnect the coil to agree with the others.

Cause 7.—Heat conveyed from other parts.

Symptom.—Other parts hotter than armature. Start with the machine cool and determine by thermometer or hand which parts heat first and to the greatest extent.

Remedy.—(See Heating of Bearings, Field and Commutator.)

Cause 8.—Unequal strength of magnetic poles may cause excessive current to flow in an armature, thereby heating it abnormally in the case of a multipolar direct-current machine with multiple-circuit armature winding.

The armature coils of an alternating-current generator or synchronous motor being usually arranged in series, the effect of weakening or even omitting one of the field poles is merely to produce a corresponding reduction in e.m.f. which may be overcome or avoided by slightly strengthening the other poles. No short-circuiting or heating is likely to result. (See "Voltage Too High or Too Low," Cause 2.)

Symptom and *Remedy* are the same as for "Sparking," Cause 9.

Note.—Any excess of current taken by an armature when running *free*, as a motor, whatever the cause, must be converted into heat by some defect, hence the "free current" is the simplest and most searching test of the efficiency and perfect condition of the machine.

THE CALORIMETRIC TESTING OF COAL.

BY GEORGE T. HANCHETT.

The testing of coal does not necessarily require a knowledge of chemistry and a system of manipulation beyond the range of ordinary power-house facilities. In reality a test can be conducted with very simple apparatus, and in a very short time. The necessary equipment is as follows: One pair of balances sensitive to 1 milligram, with sets of weights. This should not cost over $15; one pair of scales, capable of weighing to 1-10 of an ounce, costing about $3; one calorimeter made as per directions included in this article, which should cost about $5; and one thermometer graduated in single degrees from 32 degs. to 110 degs. Fahr. This can be had for about $2.

There should also be provided an iron mortar and pestle, a porcelain mortar and pestle, a few beakers, and some pieces of soft, loosely-woven cheesecloth.

A coal calorimeter is preferable made of sheet copper coated with tin, and can be made from the drawings by any tinsmith. It consists of an outer vessel, shown in Fig. 1, equipped with a perforated thermometer tube soldered on the inside. A bomb, which can best be made of brass tube, is also provided, the details of which are shown in Fig. 1. The vessel should be water tight, and particular pains should be taken to see that the bomb can be screwed together tightly. All joints which are not to be opened had better be soldered.

Before conducting the coal test one ounce bottle of peroxide of sodium should be secured. This is a very energetic compound, which readily parts with its oxygen and should be carefully handled. It should not be spilled loosely about or put in any place where it is likely to come in contact with water since there is a certain hazard of fire or explosion, and while such accidents at no time would be serious, they are likely to take place in the absence of the experimenter, and grow to uncontrollable proportions before he returns.

The sample of coal to be tested should be selected by taking a shovelful from many parts of the pile and heaping them together on the floor of the boiler room or by taking periodic samples from the stream of coal as it enters the bunkers. These shovelfuls should be thoroughly mingled and the pile quartered. One quarter should be selected and the process repeated until enough has been secured to fill an ordinary Mason jar, into which the coal should be put and tightly sealed.

The jar and its contents should first be weighed and a record made of it. The coal should then be spread out in a thin layer on a sheet of paper and allowed to become thoroughly dry. The process can be hastened by placing the coal in a tin baking pan and heating it on top of a hot stove until all the moisture has been expelled. As soon as it is thoroughly dried the coal should be returned to the Mason jar and reweighed. The jar should be thoroughly cleaned out and weighed also, and its weight deducted from that originally observed. It will be found that the mixture has lost weight by drying. Dividing the lesser weight by the greater the percentage of coal in the mixture will be found, the difference between this figure and 100 per cent is the percentage of moisture which is the first item of interest to the coal user.

The dried coal is now quartered and requartered as before until a sample weighing about 2 ounces is had. This should be powdered in the iron mortar to the size of rice, and again quartered until about 3 metric grams are secured. This should be returned to the iron mortar and ground to

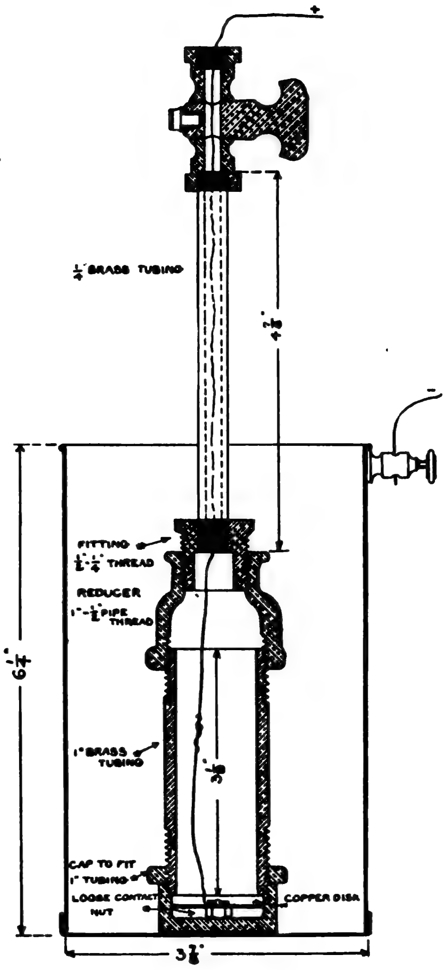


FIG. 1.—COAL CALORIMETER.

the consistency of ordinary sand. About one-half of this mixture can now be transferred to the porcelain mortar and should be ground very fine indeed. A small piece of thin cheese cloth can be stretched over the top of the beaker, and occasionally the coal can be sifted through into the beaker, the coarser particles retained by the cheesecloth being returned for further trituration. The finished sample should be as fine as ordinary flour. One gram of this is carefully weighed and mixed with 18 grams of peroxide of sodium. It is essential that the mixing be thorough and complete. The mixture is to be carefully packed in the bomb; but before it is placed in the bomb, this latter device must be made scrupulously clean and free from moisture, since any moisture entering the bomb will make a serious error in the results giving the coal a thermal value altogether too large. A flat or disc of copper must also be inserted and attached to an iron wire of about No. 34 B. & S. gauge. This iron wire should be long enough to thread through the mixture, and after leaving the same is fastened to a No. 32 copper magnet wire, which is threaded through the upper tube of the bomb and through the pet cock. The calorimeter and filled bomb should now be carefully weighed and the weight recorded and then water added to just cover the bomb. This water is also weighed. The calorimeter and bomb being made of brass and copper can be taken to have a specific heat of .095, and multiplying the weight of the metal by this a value is obtained which is known as the water equivalent of the apparatus. If the calorimeter weighs 2 pounds, the water equivalent would therefore be .190.

It will be found convenient to select a weight of water such that when added to the water equivalent of the calorimeter, the result will be an even number of pounds, and having ascertained this weight, it will be well to make a counterpoise of the proper amount which can be used for weighing in all subsequent experiments. If the even number representing the equivalent weight of the water is to be 4, the actual amount of water used should be 3.810. To this should be added the weight of the calorimeter, 2 pounds, making a total of 5.81, and a counterpoise should be made of that weight. This greatly simplifies the weighing in subsequent experiments, for it is only necessary to put the completed calorimeter on one side of the balance and the counterpoise on the other and add water until the scale balances.

If the foregoing figures have been assumed, the heat developed during the experiment can be at once translated to British thermal units by multiplying the degree rise in the thermometer by 4, which figure can be termed the constant of the calorimeter. Of course, it is plain that a similar system of reasoning could be employed to use any other even figure. Having prepared the calorimeter with its water, the bomb should be removed to preclude the possibility of slow leakage, and the water allowed to stand until it has reached the temperature of the room or nearly that. If this is done there will be little possibility of error by radiation for the difference in temperature in the calorimeter and its surroundings will be small at any stage of the experiment. When the temperatures have been thus adjusted, the calorimeter should be reassembled and restored to the scales, enough water being added to make up for any loss by evaporation, and the initial temperature noted. A bank of ten lamps should be connected in series with the wire protruding from the stop cock of the calorimeter and the calorimeter itself at the binding post provided for the purpose, and when all is ready the switch should be closed. This will heat the short length of wire imbedded in the mixture to the melting point and ignite the mixture, the ignition being revealed by smoke appearing at the orifice of the stop cock, which should be closed

at the first sign of ignition. In closing it will cut the soft piece of 32 magnet wire and effectively seal the bomb and its contents.

The combustion in the bomb will continue for about half a minute. Very little pressure will be developed as the gases evolved are rapidly absorbed by the residual salt, and it will be found when the bomb is opened at the close of the experiment that there will be no puff of gas due to the reaction.

As soon as the mixture is ignited, the temperature will rise, due to the combustion, and for about two or three minutes thereafter the contents of the calorimeter should be thoroughly stirred by means of the bomb. The maximum temperature should be noted, reading the thermometer to tenths, and the difference between the initial and final temperatures multiplied by the constant of the calorimeter, determined as indicated, will give the B. T. U. contained in 1 gram of coal, subject to the following correction.

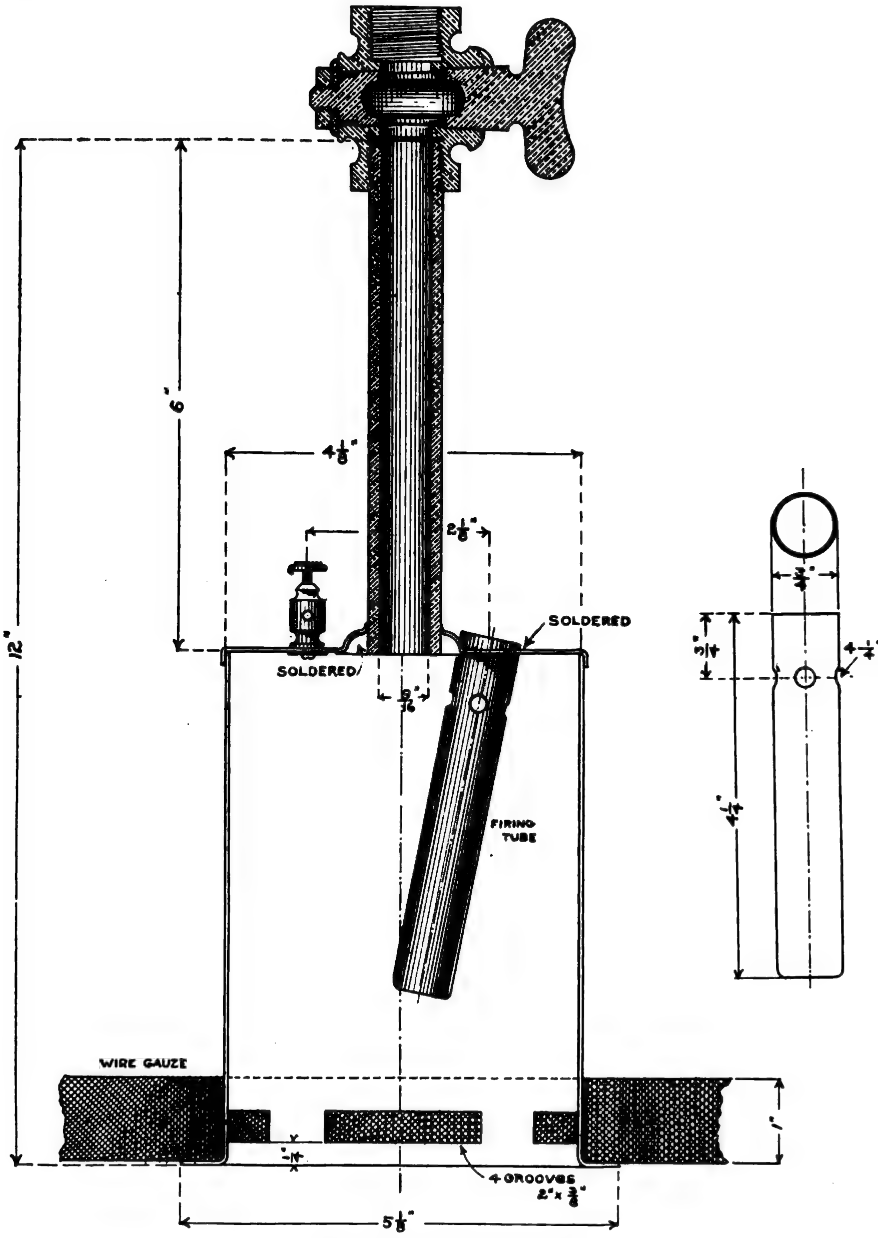


FIG. 2.—COAL CALORIMETER.

This correction is the deduction of 27 per cent. of the observed heat units, or, in other words, multiply the observed heat units by .73. This is necessary because the reaction is exothermic and generates heat, and it has been found by careful chemical test that the amount of heat generated due to chemical reaction is substantially in this proportion no matter what the thermal value of the coal, and it is sufficiently accurate for all practical purposes. At the close of the experiment a hard, greenish deposit will be found in the bomb, which can readily be removed by soaking in hot water.

Having found the B. T. U. in one gram, it is very easy to obtain the thermal units in one pound by multiplying by 453.59. If carefully done this experiment will be found to be capable of repetition and check within one-tenth of one degree, and as the rise in temperature is from 8 to 10 degs., the process is accurate to within nearly 1 per cent.

Another form of coal calorimeter may be constructed with a similar outer vessel, and with an inner vessel constructed as shown in Fig. 2. This vessel, as the illustration shows, consists of a cylinder open at the bottom and equipped at the top with a stop cock and tube. A firing tube is also provided, having holes in the upper part, and in this firing tube are packed two grams of coal, 7½ grams of chlorate of potash and 2½ grams of nitrate of potash, thoroughly powdered and mingled. The calorimeter is assembled, due correction being made for the weight of the calorimeter and the usual observations made with reference to temperatures and weight of water. The mixture is fired through the upper hole of the inner cylinder, preferably by drawing an arc at the side of the firing tube and the wire. The mixture is not readily ignitable, and several arcs may be necessary before combustion takes place. As soon as the combustion begins, the upper end of the fire tube should be sealed with a rubber stopper shod with metal. The moment the stopper is inserted, the pressure of the gas issuing through the small holes in the firing tube will depress the level of the water and presently the gas will bubble out of the bottom of the cylinder or through the small holes at the bottom covered with gauze, as shown in the figure. The escaping gases are supposed to give up their heat to the water. The initial and final temperatures are noted as before. After combustion is complete, the upper stopper should be opened or the plug removed from the firing tube. The water will then rise and come in contact with the hot firing tube and absorb still more heat, and the final temperature should not be taken until all of the heat from the reaction has been thoroughly absorbed by vigorous stirring and quenching of the firing tube as above described. This is a well-known process, but is subject to serious error. The thermal values obtained without correction are always too small, and yet the reaction is an exothermic one, and the amount of heat liberated is larger than that contained in the powdered coal. One of the principal sources of error is due to imperfect combustion, which can be corrected for by thoroughly leaching the mixture in the firing tube, carefully drying the deposit, weighing it, igniting it in a crucible and weighing again, charging the difference to unburned coal and pro-rating accordingly. Much heat is lost by the premature escape of the gases.

Another correction should be made for the heat of reaction, which is a subtractive one, and still another correction should be made for the solution of salt in the calorimeter, which changes the specific heat of the water and absorbs heat by the solution. The gases will come away in the form of white smoke, the white smoke being due almost entirely to finely powdered salt. These corrections are so complicated and are likely to be so varied that the process is very inaccurate, and occasion has been taken to describe it and set forth its inaccuracies because the process is well known, and the reader may thereby be saved a great deal of unsatisfactory experiment. The writer has made efforts to obtain a proper method of correcting the numerous errors which obtain with this device, and has found none of them sufficient-

ly reliable so that check readings within 10 per cent. can be had, and therefore will not venture any figures which may lead others into useless labor. It is sufficient for the purpose of this article that the method be described as one which the investigator is likely to encounter in his first investigations of the subject, and one which should be avoided. The first method, however, will be found to give very practical satisfaction.

COMMON BATTERY TELEPHONE SYSTEM.

BY W. S. HENRY.

The connections of a telephone system devised by Harry G. Webster for the Stromberg-Carlson Telephone Manufacturing Company, and about the same as is installed in at least one or two telephone exchanges, is shown in Fig. 1. It is a multiple central-energy, or common-battery, telephone system. At the right and left are shown two complete line circuits, including the subscribers' telephone instruments, *A* and *D*. Between the two line circuits is shown one cord circuit with which the operator connects together the line circuits of any two subscribers. The distinguishing feature of this system is the use of a differentially-wound line cut-off relay, *CO*. Furthermore, there are no coils or relays directly in the talking circuit.

At *E* is shown a visual electromagnetic line signal. As long as current of sufficient strength passes through the coil of *E*, the shutter is held up in such a manner as to readily indicate to the operator that the subscriber on that line desires a connection. When the current ceases the shutter drops by its own weight and covers the white spot or other signal. This is the normal position of the signal. The coils, *m* and *n*, of the cut-off relay have a resistance of about 200 ohms each and are so wound that when they are connected in series they neutralize each other and do not magnetize the iron core of the relay. The armature, *o*, normally rests against the stop, *c*. In the subscriber's telephone instrument, the transmitter, *T*, and primary winding, *p*, of an induction coil are connected in series with the line wire, this circuit being open at the hook switch contact when the receiver rests on the hook. When the receiver is removed from the hook this circuit is connected across the two line wires. When the receiver rests on the hook, a bell, *V*, and a condenser, *C*, are connected in series through a contact on the hook switch across the two line wires. The removal of the receiver from the hook switch opens the bell circuit. When the subscriber's receiver rests on the hook switch no direct current can flow through the bell circuit, although the bell circuit is closed at the hook switch because the ½-microfarad condenser, *C*, forms an open circuit to a direct current; but an alternating current of about 20 cycles per second, such as the current used for ringing purposes, can readily pass through the condenser and ring the subscriber's bell.

The system operates about as follows: When subscriber, *A*, removes his receiver from the hook, the transmitter, *T*, of about 40 ohms resistance and the primary winding, *p*, of about 15 ohms resistance are connected in series across the line circuit. This resistance is low enough to allow sufficient current to flow from the central exchange battery, *B*, through the coil, *m*, line *L*, winding *p*, transmitter *T*, line L^1, armature *o*, contact *c*, coil *n*, signal *E*, to cause the latter to display its signal. The current in coils, *m* and *n*, tends to magnetize the core of the relay, *CO*, in opposite directions, hence the relay is not affected and remains inert. The display of a signal by *E* attracts the attention of the operator, who inserts the answering plug, *P*, in the subscriber's answering jack. Current now

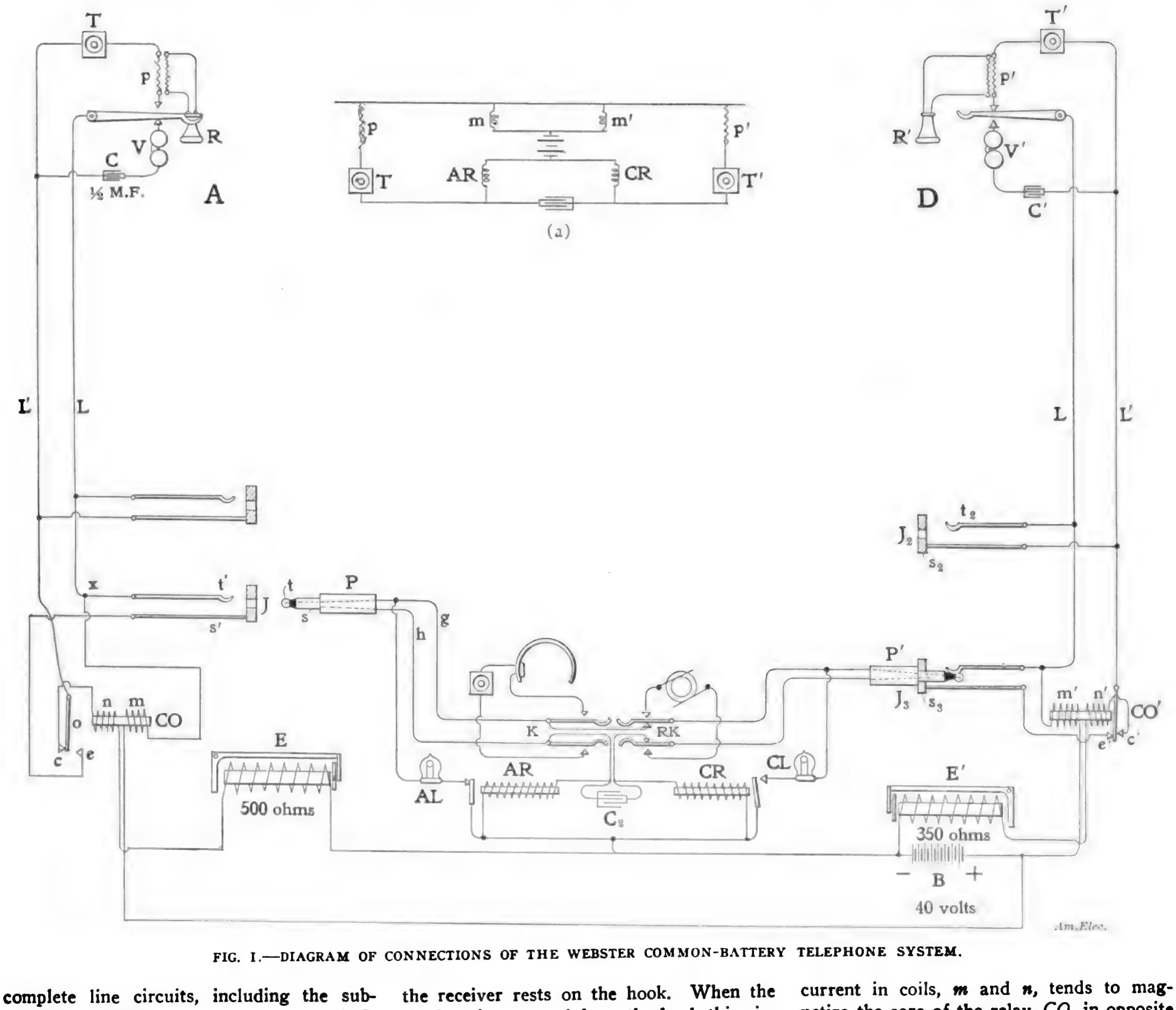


FIG. 1.—DIAGRAM OF CONNECTIONS OF THE WEBSTER COMMON-BATTERY TELEPHONE SYSTEM.

flows from *B* through *m* to *x*, where it divides, part flowing through *t'*, *t*, *AL*, and part through line *L*, winding *p*, transmitter *T*, *o*, *c*, *n*, *E*, back to the battery. The line signal, *E*, has so much higher resistance (350 ohms) than the supervisory lamp, *AL*, which is a 20-volt lamp, that the greater current through coil *m* is sufficient to energize the cut-off relay, *CO*, thereby transferring the sleeve side, *L'*, of the line from connection through *c* to coil *n* to the connection with the answering supervisory relay, *AR*, through contact, *e*. Current now flows from *B* through *m* to *x*, where it divides, part flowing through line *L*, primary winding *p*, transmitter *T*, line *L'*, *o*, *e*, s^1, *s*, *h*, relay *AR*, back to the battery, thus energizing the answering supervisory relay, *AR*, which opens the circuit through the answering supervisory lamp, *AL*, and hence extinguishes it.

The operator now closes her listening key, *K*, which connects her transmitter and receiver in series across the line circuit, and hence her transmitter circuit is in parallel with the subscriber's circuit. Both these circuits are supplied with current from the battery, *B*, which is bridged across the line circuit through coils *m* and *AR*, each having a resistance of about 200 ohms, which act as impedance coils as well as relays. The operator's listening set may be connected in the same manner as the subscriber's talking circuit or in any other suitable manner.

The operator ascertains the number of the subscriber desired, and then makes the usual busy test by touching the tip of the calling plug to the sleeve of the desired subscriber's jack. If there is no plug in any other jack belonging to the desired subscriber's line, the line *L'* will be open at the subscriber's hook switch; hence s_2, the sleeve of the jack touched, will have the potential of —*B* (through *c'-n'-E'*) and the tip of the plug will also have the potential of —*B* (through the supervisory lamp *CL*), hence there is no disturbance of the conditions previously existing and no click will be produced in the operator's receiver, and she will insert the plug in the jack. However, if there is a plug in the answering jack, J_3, or in any multiple jack, then current will be flowing from —*B* through the sleeve side of the cord circuit in use, and the sleeve of the jack in which the plug has already been inserted. Consequently, the sleeves of all jacks of the busy line will have a potential differing from that of —*B* (due to the drop of potential through a supervisory relay) and hence, different from that of the tip of the plug used in making the test; consequently, a click, denoting a busy line, will be made in the operator's receiver the moment the tip of the plug is touched to the sleeve of a busy line.

When the calling plug is inserted in the jack of a line not busy, say in jack J_2, no current can flow through the supervisory relay, *CR*, because the line, *L'* is open at the subscriber's hook switch, and there is no tendency for current to flow through *c'-n'-E'*, hence the supervisory relay, *CR*, will not be energized; but the cut-off relay will be operated by the current through *m'*, thus cutting off the line signal, *E'*, and the supervisory lamp will be lighted. When the ringing key is closed, alternating current will flow through the line, condenser *C'* (½ microfarad) and bell *V'*, and ring the latter.

When the desired subscriber takes down the receiver, current will flow from *B* through *m'*, line *L*, subscriber's coil *p'* and transmitter *T'*, line *L'*, s_2, *CR*, back to *B*, thus energizing both *CR* and *CO'*, and therefore extinguishing the supervisory lamp, *CL*.

When the subscribers finish their conversation, each supervisory lamp will light as each subscriber hangs up his receiver. For instance, if the receiver, *R'*, is hung up, no current can flow through the supervisory relay, *CR*, hence *CL* lights up and the cut-off relay remains energized until the plug is removed from the jack. When both plugs are removed, the cut-off relays will release their armatures, thereby connecting the line signals to the line wires ready to receive another call.

It will be noticed that the subscriber's receiver is in a permanently closed local circuit containing one winding, *s*, of an induction coil. Many independent telephone manufacturing companies use this arrangement successfully. An incoming voice current flows through the primary winding, *p*, and induces a current in the secondary winding, *s*, which causes the receiver to give out the proper sounds. The transmitters have a resistance of 40 ohms or more, and each winding of the induction coil about 15 ohms. On account of the high resistance of the transmitter and the fact that speaking into it will produce a large variable resistance, the total resistance of the line circuit is sufficiently altered when talking into it to produce very good results. At *a* is shown the connections that exist during the conversation. In this diagram all apparatus and connections not forming a part of the talking circuit have been omitted.

Demand Meters in Boston.—The Edison Electric Illuminating Company, of Boston, which began in 1898 to experiment with the Wright demand system of charging, is now making as rapidly as possible a final extension of the system to all its customers, both for light and power. Hitherto the Wright demand indicator has been used by the company for installations of fifteen lights or more (the demand of customers having less than fifteen lights being assumed equal to the installation), but its use is now to be extended to all contract customers having five or more lights. To make these extensions over 4000 Wright demand indicators will be installed. A most interesting feature of the change to central station men is that with the extension of the Wright demand system, the Boston Edison Company will put into effect a scale of rates which it is expected will completely do away with the inconvenience and expense of figuring out what rate a customer is entitled to. This new scale of rates is designed automatically to give to each customer a rate bearing as nearly as possible a definite ratio to the cost of supplying him.

Principles of Electrical Apparatus

THE SYNCHRONOUS MOTOR.

If an ordinary alternating-current dynamo be driven at normal speed by some outside source of motion (such as a belt from a motor or a running line-shaft), with its field separately excited by direct current, and then connected to an alternating-

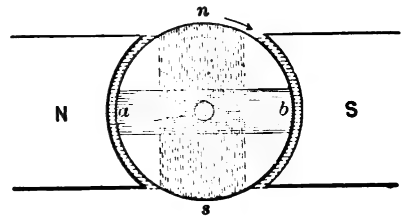


FIG. 1.

current circuit at some instant when its impulse of e.m.f. coincides exactly with that of the circuit, the mechanical connection with the source of motion may be removed and the machine will continue running, being now driven as a motor by current from the circuit. Such a machine is a synchronous motor. This type of motor is like a direct-current motor in one respect, and only one; namely, its construction is, fundamentally, exactly like that of the dynamo that generates the sort of current on

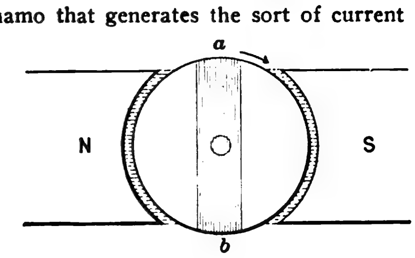


FIG. 2.

which it (the motor) is designed to operate.

Synchronous motors run at precisely the same rate of speed as that of the alternator supplying the circuit on which they run, if the number of magnet poles is the same; hence their name "synchronous." If the poles differ, then the relation between the speeds of the motor and the generator is given by the simple equation

$$P\,S = p\,s \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

in which *P* represents the number of poles on the generator; *S*, its speed; *p*, the number of poles on the motor, and *s*, its speed.

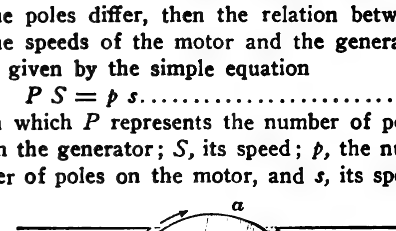


FIG. 3.

The formula is obviously transposable four ways, according to which of the four values one wishes to determine. If *S* and *s* be expressed in revolutions per minute, the frequency, *f*, of the current supplied by any alternating-current generator is equivalent to $P\,S \div 120$, and the relation between the speed of a synchronous motor and the fre-

quency of the current that drives it is expressed by the equation

$$120 f = p\, s \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

from which obviously follow the formulæ

$$\frac{120 f}{p} = s, \quad \text{and} \quad \frac{120 f}{s} = p.$$

The truth of the foregoing statements may be demonstrated by elementary diagrams, such as Figs. 1 to 7. Here, for

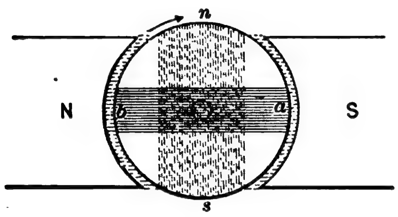


FIG. 4.

the sake of simplicity, a bipolar field magnet and single-coil armature are shown. Suppose the armature to be driven by a belt at such a rate that the armature makes precisely one revolution while the current wave of the supply circuit passes through precisely one cycle; then, if the armature be properly connected to the circuit, it will occupy the position in Fig. 1 when the supply current is at its maximum (neglecting for the present the counter e.m.f., inductance, etc., of the armature), as indicated by the Roman numeral, I, on the current wave, Fig. 7. The armature connections having been properly made, the supply current will induce poles at the periphery of the armature core, as indicated by the letters *n* and

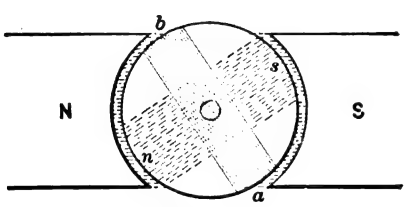


FIG. 5.

s, so that there will be a pull between the field-magnet poles and the armature core tending to assist the rotation of the latter. When the armature core has passed through one-quarter of a revolution, and reached the position shown in Fig. 2, the current will have passed through one-quarter of its cycle and reached zero, as indicated by the numeral II in Fig. 7.

In this position the armature will not have any magnetic poles, but an instant later, when the coil has passed the vertical position, as indicated in Fig. 3, the current will have begun to rise in the opposite direction, as indicated by the numeral III in Fig. 7, producing reversed poles on the armature periphery and resulting in a repulsion between the armature core and the field-magnet poles which renews the rotatory effort in the same direction as before. When the armature reaches the position shown in Fig. 4, having made exactly half a revolution, the current will have attained its maximum direction again, which series of changes is continued so long as the armature revolves at the rate of one revolution per cycle of current. It is evident that under these conditions the armature does not need to be driven by any external source, as the magnetic torque between it and the field poles will cause it to continue to revolve.

Should the speed of the armature be either higher or lower than the frequency of the supply current, the angular or tangential torque between the field-magnet poles and the armature core will be alternately favorable and unfavorable to the direction of rotation. For example, if the armature in passing from the position shown in Fig. 4 should be driven at a rate of speed lower than the frequency of the supply current, so that by the time it reaches, let us say, the position shown in Fig. 5, the supply current will have passed zero and reversed, as indicated by the numeral V in Fig. 7, then poles will be induced in the armature core as indicated in Fig. 5, and the torque between the magnet poles and the armature

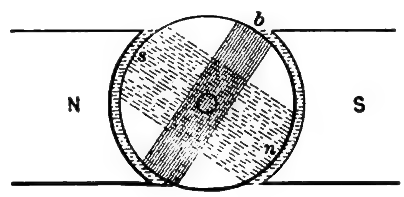


FIG. 6.

will be opposed to its direction of rotation. Again, if the speed of the armature should be more rapid than the rate of current reversals to such an extent that it would be driven from the position in Fig. 4 to that in Fig. 6 before the current had reached zero, as indicated by the numeral VI in Fig. 7 the polarity of the armature will again be such that the field magnetism tends to pull it in the opposite direction. It is evident, therefore, that in order to maintain continuous torque in the same direction between the armature and field-magnet poles, the armature speed must be kept precisely in step with the current reversals. So long as the load on the armature is within its torque ability, it will

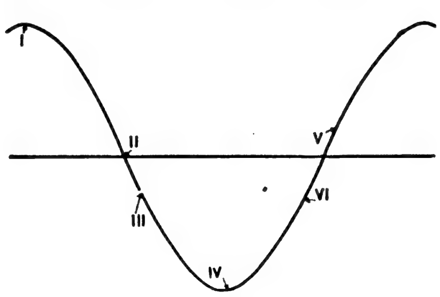


FIG. 7.

maintain synchronous speed, but the moment the drag due to the load exceeds that exerted between the magnet poles and the armature, its speed will be reduced, it will drop out of "step" with the supply current, and come to a standstill.

Letters on Practical Subjects

Communications intended for publication in this department must be received at this office not later than the 15th of the month prior to the date of publication.

Care of Storage Batteries.

With reference to the discussion on storage batteries in your recent issues, and more particularly to the communication from Mr. Hartwell, I wish to correct his statement that "as the temperature (of electrolyte) rises 10° F., the specific gravity will *rise* 3°." The converse is the case; that is, as the temperature rises 10°, the specific gravity falls 3°.

Ordinarily in stationary battery practice, the specific gravity should be 1.200 at full charge and at normal temperature, which is 70° F. At other temperatures, allowance should be made accordingly in adjusting the specific gravity. Variations in the temperature materially affect the capacity of a battery. At a temperature between 90° and 100° F. a battery will yield its greatest output. It is not advisable, however, to maintain the temperature at so high a point as this, deterioration of the plates being then more rapid. At such a temperature, the internal resistance and the required maximum charging voltage are lower than at normal temperature (70° F.). On the other hand, the capacity at a very low temperature, say 32° F., is considerably reduced, the internal resistance greater and the required maximum charging voltage greater than at normal temperature. Roughly, the capacity varies 1 per cent with every 2° F. change in temperature between 32° and 90°. Notwithstanding the loss of capacity at lower temperatures, the plates are not injured, and the cells recover their capacity when the temperature is restored to normal.

The charging voltage under normal conditions of temperature, specific gravity and of the active material is governed by the age of the plates and is best determined by the results secured by employing different voltages, as no specific rule can be given to show the maximum voltage to be used in any particular stage of deterioration.

Yonkers, N. Y. W. L. THOMPSON.

A Telephone Circuit Difficulty.

We have a bridged telephone line with ground return, and except in a few cases, all grounds are made by soldering to well pipes. The exceptions are 6-foot and 8-foot ground rods driven into sandy soil. During the latter part of the winter those subscribers having instruments grounded to rods are unable to ring the bells of other parties on the line, although their own bells respond to an incoming signal as well, apparently, as ever. These same generators when grounded to well pipes signal as well as ever, showing that the generators are

not at fault. The ground rod connection seems to be sufficient for conversation, but the generator cannot put enough current to line to ring other bells. In this case there are twenty telephones on the line, hence, neglecting line resistance, 1/20 of the output of any generator will pass through each bell and ground, except the ground of the generator in use. Here 1/20 of the output passes through the bell and 19/20 pass to line to actuate the other 19 bells. Now, the resistance of a conductor is constant at a given temperature, regardless of the current or e.m.f. passing through it. Such being the case, I should like to ask readers of the American Electrician to explain why these ground rods will pass 1/20 of the current put out by other generators, but will not pass the 19/20 that should be sent to line by their own generators.

Osage, Minn. W. H. Shadbolt.

Mr. Weaver's Problem in Switches.

Referring to Mr. Weaver's problem last month, I would suggest the enclosed scheme of connections (Fig. 1). This is not quite up to requirements, if I understand his letter aright, but it is workable. In order to light the lamp, *U*, from downstairs, the switches, *b* and *f*, are closed, and in order to light the lamp, *D*, the switch *d* is closed to the left as the diagram stands. The upstairs switches, *a*, *c* and *e*, work with these switches to give two-station control. In order to put the lamps in series, the switch, *g*, is closed to the right and the switches, *a* and *c*, thrown to whichever side is necessary to open their respective circuits, according to the positions of the switches, *b* and *d*. Then the lamps in series can be extinguished from downstairs by throwing the switches, *b* and *d*.

Ironwood, Mich. Louis J. Gorilla.

Enclosed please find a solution to the problem offered by Mr. B. F. M. Weaver last month (Fig. 2). The switch, *A*, is double-pole, double-throw and the others are all single-pole, double-throw, or they may be single-pole, two-way snap switches.

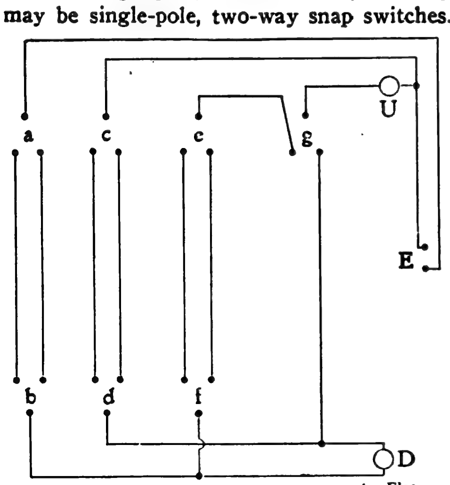


FIG. 1.—MR. GORILLA'S SOLUTION.

With the switch *A* thrown up, the lamps may be controlled separately from either upstairs by means of the switches, *B*, and *E*, or from downstairs by means of the switches *C* and *F*. With the switch *A* thrown downward, the lamps are in series, and may be lighted and extinguished from any one of the four single-pole switches.

Wilkinsburg, Pa. F. W. Harris.

The enclosed diagram (Fig. 3) is submitted as a solution of Mr. Weaver's problem published last month. The switches are all three-point, single-pole, and with the switch *C* closed to the right, the switches *A A'* control the lamp, *D*, on the

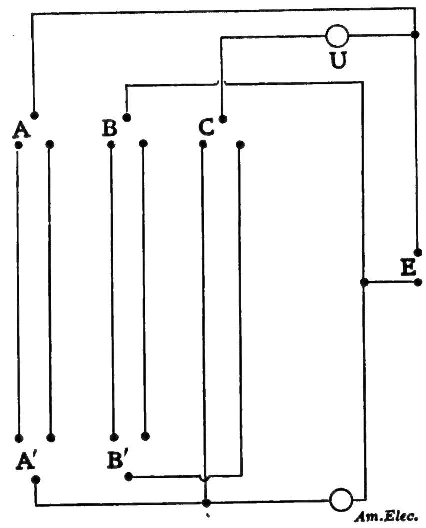


FIG. 3.—MR. LOVELAND'S SOLUTION.

ordinary two-station plan, while the switches *B B'* control the lamp *U* in the same manner. The switch *C* when closed to the left puts the two lamps in series, provided the circuit between the switches *A* and *A'* is open, which can be accomplished, of course, by throwing *A* one way or the other, according to the position of *A'*.

Philadelphia, Pa. Wm. A. Loveland.

[Mr. Loveland's solution fails in the one requirement that the lamps when in series shall be controllable from either upstairs or downstairs.—Editor.]

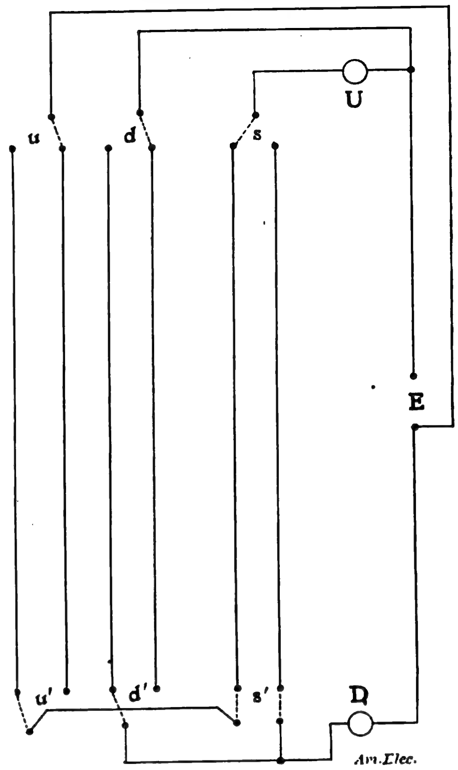


FIG. 4.—MR. MALCOLM'S SOLUTION.

The accompanying diagram (Fig. 4) is offered as one method of accomplishing the results described by Mr. B. F. M. Weaver last month, and a little more; it gives complete control from both stations. With the switches set as in the diagram the lamps are extinguished. Throwing either *u* or *u'*

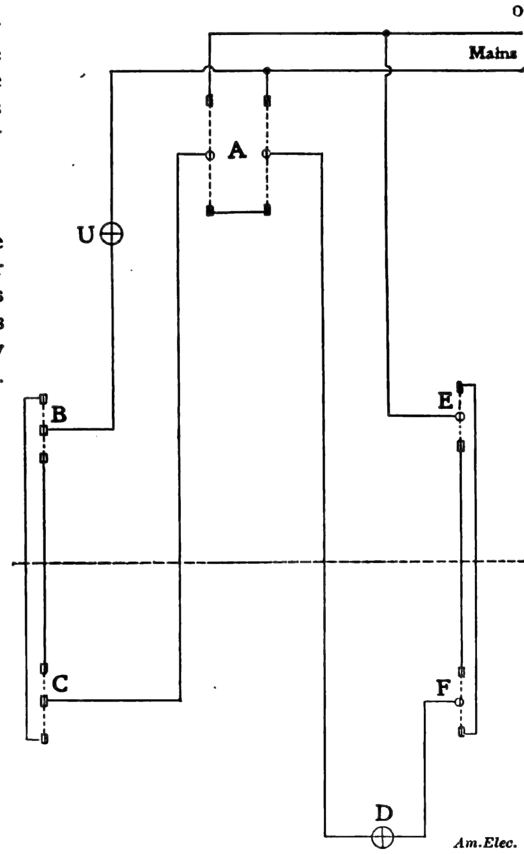


FIG. 2.—MR. HARRIS' SOLUTION.

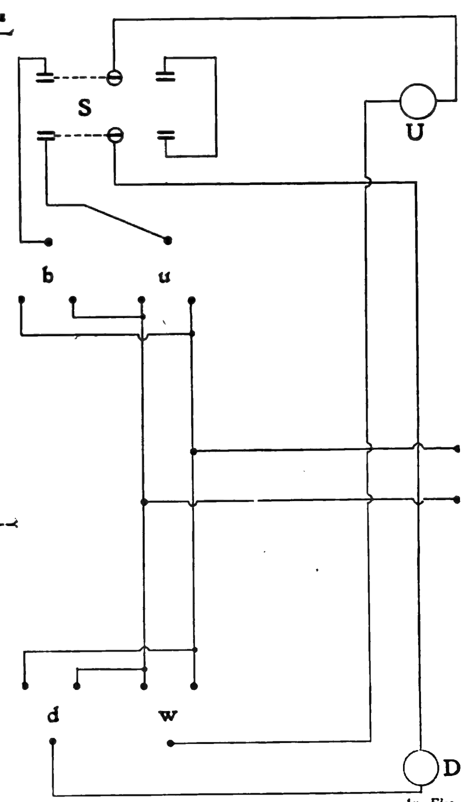


FIG. 5.—MR. MERRILL'S SOLUTION.

will light the lamp *U*, after which throwing either of them will extinguish it. The same is true of the switches *d* and *d'* and the lamp *D*. Again with the switches as in the diagram, throwing either *s* or *s'* will put the two lamps in series on the line, and the next throw of either of these switches will extinguish them. Therefore, the lamps can be controlled separately, in parallel or in series from either station, regardless of the positions of the switches at the other station.

Brooklyn, N. Y. GEO. W. MALCOLM.

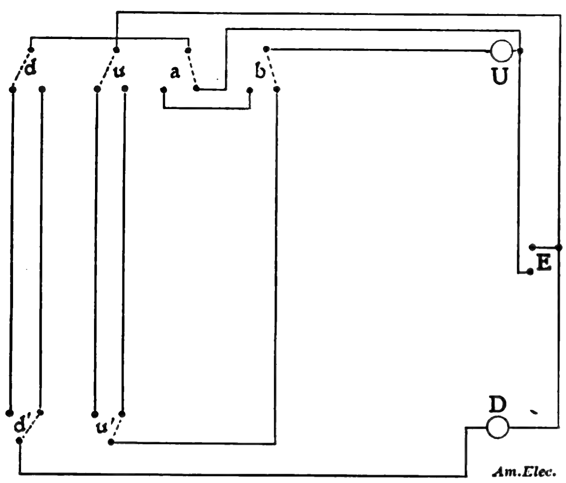
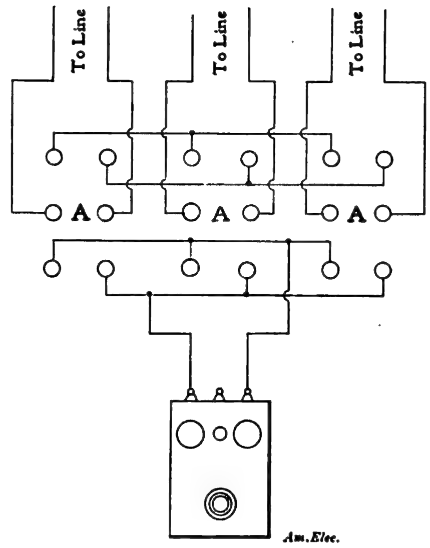


FIG. 7.—MR. WEAVER'S SOLUTION.



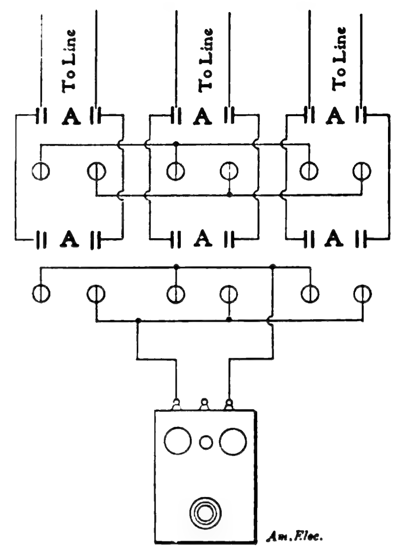


FIG. 1.—MR. EDDY'S SOLUTIONS TO MR. BRODE'S PROBLEM.—FIG. 2.

I enclose herewith a diagram of switch connections (Fig. 5) which is offered as a solution of Mr. Weaver's problem published in your last issue. The double-pole, double-throw switch, *S*, puts the lamps either in parallel or in series, and the three-point switches, *u* and *w*, control the lamp *U* while the switches *d* and *b* similarly control the lamp *D*, when the switch *S* is in the parallel position (that shown in the sketch). When the switch *S* is thrown to the right, putting the lamps in series, they can be lighted and extinguished by any one of the four three-point switches.

Wilmington, Del. WM. MERRILL.

The enclosed diagram (Fig. 6) shows a possible arrangement for solving Mr. Weaver's problem in switch connections published last month. Five three-point and two electrolier (double-pole reversing) switches are employed. With this arrangement either or both of the lamps may be lighted and at full candle-power and extinguished from either station, independently of the switches at the other station, and the lamps may be put in series from the upstairs station; when in series they can be turned on and off at either station.

Syracuse, N. Y. N. D. RAND.

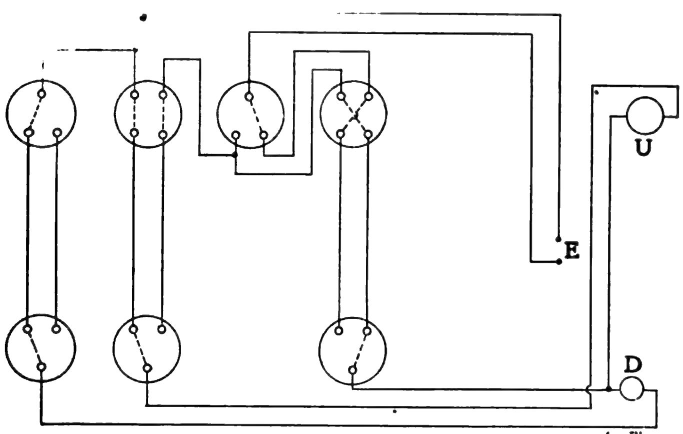


FIG. 6.—MR RAND'S SOLUTION.

[Fig. 7 shows Mr. Weaver's own solution of his problem, and is almost self-explanatory. The switches are all three-point, single-pole. As they are shown in the diagram, the lamps are out, and may be lighted and extinguished separately by means of the switches *d*, *d'*, *u* and *u'*; throwing the switches *a* and *b* to the left puts the lamps under the control of the switches *d* and *d'* in series. It is quite obvious that the switches *a* and *b* could be displaced by a double-pole, two-way switch.—EDITOR.]

Mr. Brode's Problem in Telephone Connections.

I submit herewith two diagrams (Figs. 1 and 2) as solutions of Mr. Brode's problem in telephone connections which was published in this department last month. In Fig. 1 three double-pole, double-throw knife switches are used, each switch being arranged to connect one of the lines to a pair of cross-connecting bus-wires when thrown upward or to the local telephone instrument when thrown downward. One of the switches would always be down and the other two up, to fulfill the conditions of the problem. One disadvantage of this arrangement is that a person at the station where this is located cannot listen in on either of the two wires which are connected together without disconnecting the two. In order to remedy this, the second solution is offered. Here six double-pole, single-throw switches are used; the upper three are used to cross-connect and the lower three, one at a time, to connect the local instrument with any one of the three lines. The extension call bells are not shown; they are, of course, connected one to each line above the switches in both solutions.

So. SHAFTSBURY, VT. J. G. EDDY.

[Exactly the same solution as Fig. 1 has been received from Ernest Prosch, Coytesville, N. J.—EDITOR.]

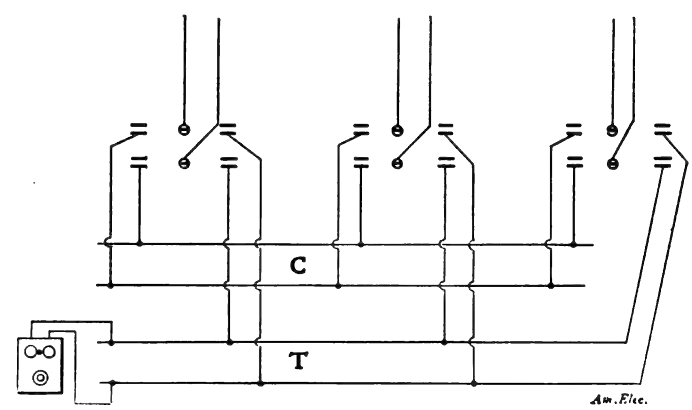


FIG. 3.—MR. HOLMES' SOLUTION.

I enclose herewith a solution of Mr. Brode's problem in telephone connections (Fig. 3): Each of the three lines is connected to the pivots of a double-pole, double-throw knife switch, and these switches connect their respective lines either to a pair of cross-connecting busses, *C*, or to the local instrument busses, *T*.

Brooklyn, N. Y. C. E. HOLMES.

The accompanying diagram (Fig. 4) fulfills the requirements contained in Mr.

Brode's letter last month. The switch, *A*, connects line No. 2 to either line No. 1

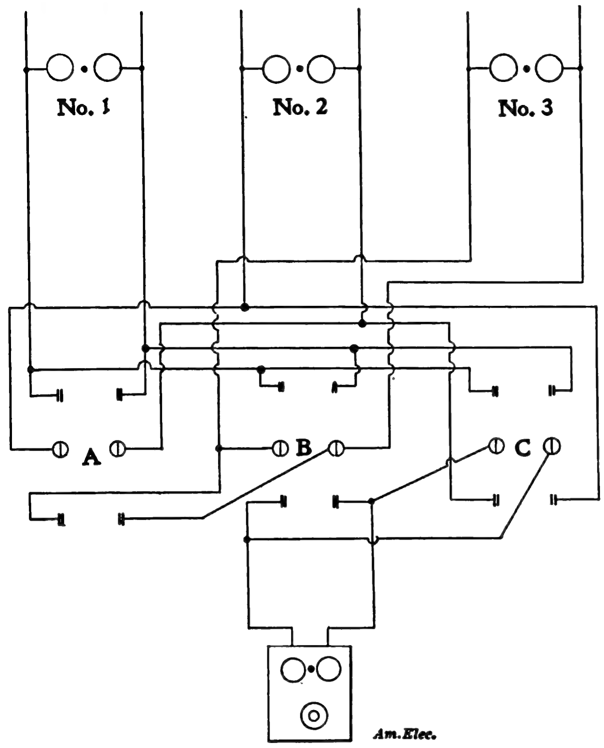


FIG. 4.—MR. LOVELAND'S SOLUTION.

or line No. 3; the switch, *B*, connects line No. 3 either to line No. 1 or to the local instrument; the switch, *C*, connects the local instrument either to line No. 1 or to line No. 2. By following out the combinations it will be found that any two lines may be connected together and the local instrument connected to the remaining line; also that no matter which two lines are connected, the local instrument can be disconnected from the remaining line and cut in on the two connected lines to "listen in" so as to prevent liability to cut the lines in the middle of a conversation.

Philadelphia, Pa. W. A. Loveland.

The enclosed sketch (Fig. 5) shows one way to solve Mr. Brode's problem in telephone connections. Three double-throw, double-pole knife switches are used to control the line connections; the lower jaws of these are cross-connected, so that closing

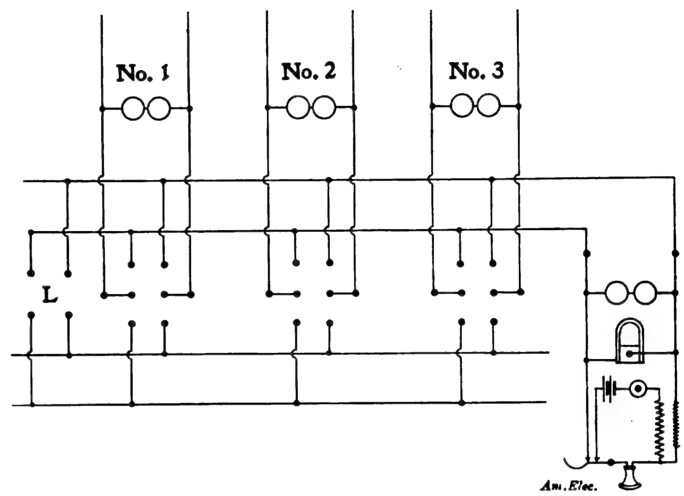


FIG. 5.—MR. WILSON'S SOLUTION.

any two switches downward connects the two corresponding lines. The upper jaws are also cross-connected, and are connected in addition to the local telephone instrument, so that closing any switch upward puts the instrument on the corresponding line. In order to "listen in" on the two connected lines without breaking the connection, the single-throw switch, *L*, is closed. All switches should be left open when the lines are idle.

Carlisle, Ind. M. C. Wilson.

Mr. Wolf's Problem in Motor Connections.

The accompanying sketch is an ideal way of controlling a motor from two points, as required by Mr. Wolf's problem last month. The motor starter is of the automatic electrically-operated type, the motor circuit being closed and the armature resistance cut out by a solenoid excited from the work circuit. The wires, *c*, *c'*, carry the current for the solenoid, and may, therefore, be No. 12 or 14 gauge. The wire, *c'*, is always connected to one side or the other of the supply mains (which is allowed with this type of apparatus) by the double-throw, single-pole switch, *S'*, and the wire *c* is similarly connected by the switch, *S*; the two switches thus give two-station control to the starting solenoid. The No. 8 wires carry the motor current.

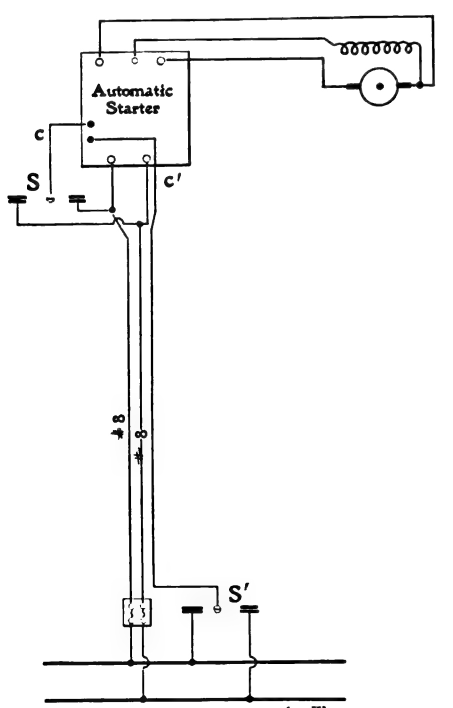


FIG. 1.—MR. BARBER'S SOLUTION.

North Adams, Mass. W. J. Barber.

Mr. Wolf's problem in motor connections is easiest solved by putting an automatic mot--starter on the upper floor with the motor and controlling the starter by means of the familiar two-station control used for incandescent lamps. Fig. 2 illustrates how this may be done. It also shows that a

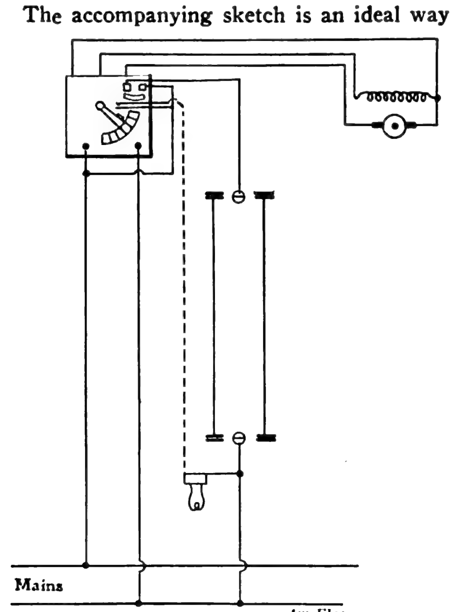


FIG. 2.—MR. LOVELAND'S SOLUTION.

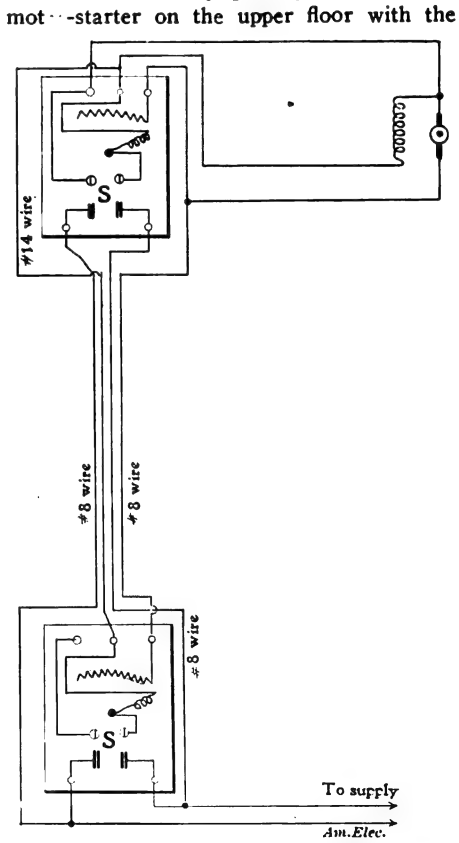


FIG. 3.—MR. MALCOLM'S SOLUTION.

pilot lamp could be connected up to auxiliary contacts on the motor-starter, these contacts to be closed by the starter arm. The dotted lines show this connection.

Philadelphia, Pa. W. A. Loveland.

The sketch herewith (Fig. 3) shows the simplest method of solving Mr. Wolf's problem with ordinary starting boxes. The diagram is so obvious that no explanation is necessary beyond saying that the swinging arms of the starting boxes have been omitted, the pivots merely being indicated by the black dots in the centers of the boxes. This arrangement makes each starting box and its main switch, *S*, entirely independent of the other one when the motor is at standstill; of course, the motor cannot be shut down from one station after it has been started from the other one; if it should be desired to do this, an automatic starter could be employed and controlled on the ordinary two-station plan by three-point switches and No. 14 wires. Geo. W. Malcolm.

Brooklyn, N. Y.

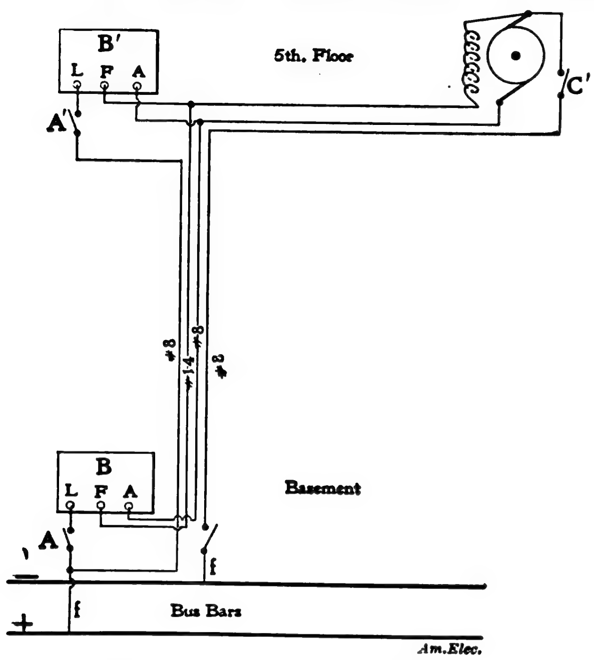


FIG. 4.—MR. SWEETNAM'S SOLUTION.

Referring to Mr. Wolf's problem, I would suggest the arrangement shown in the enclosed sketch (Fig. 4). The starting boxes are of the ordinary no-voltage release type. The motor may be started from either point by closing the switch, *A* or *A'*, and manipulating the corresponding starting box. If it be desired to shut it down from one point after it has been started from the other one, the switch, *C* or *C'*, would be opened long enough to let the starting box release, and then closed again. Fuses must be inserted at *f, f*.

A. H. Sweetnam.

Lafayette, Ind.

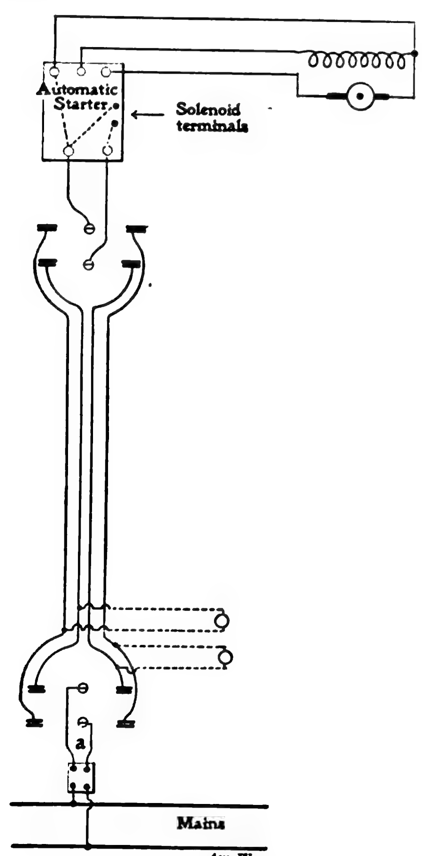


FIG. 5.—MR. TEEL'S SOLUTION.

I would like to offer the following solution of Mr. Wolf's problem: An automatic starter is installed upstairs with the motor and controlled by means of two double-pole, double-throw switches. As both poles of these switches carry the full motor current, all four of the wires in the conduit must be No. 8. The solenoid of the automatic starter is connected across the main circuit upstairs, as indicated in the sketch (Fig. 5). I would suggest that an ammeter be inserted in the circuit just beyond the fuse block, at *a*, to indicate whether or not the motor is working.

Aquashicola, Pa. John W. Teel.

[A less expensive method of indicating the condition of the upstairs circuit would be to connect up two pilot lamps as indicated by the dotted lines which we have added to Mr. Teel's excellent diagram.—Editor.]

Mr. Bannister's Dynamo Trouble.

Referring to Mr. Bannister's dynamo trouble, I would suggest that when the armature leads were short-circuited no current was supplied to the field magnet coils, and the field magnetism died out; the armature current then magnetized the field magnet poles in the contrary direction, and when the machine was next started up the leads to the field winding had to be reversed to correspond to the reversed field polarity.

Brooklyn, N. Y. Herbert B. Brand.

Mr. J. T. Bannister's dynamo trouble, mentioned in this department last month, was probably due to self-induction of the line or some apparatus on the line which caused a discharge through the field winding when the armature leads were short-circuited, and thereby reversed the residual field magnetism. It will be noticed when an armature is short-circuited that the flashing at the brushes is intermittent, as though a surging, or alternate charging and discharging were occurring.

Philadelphia, Pa. W. A. Loveland.

[The reversal of the residual field magnetism of Mr. Bannister's dynamo had nothing to do with the necessity for reversing the field winding connections. A shunt-wound dynamo will operate with either polarity without changing the leads or any connections whatever; if it happens to "pick up" with the right-hand terminal positive, for example, it will operate with that polarity, and if it happens to "pick up" with the left-hand terminal positive, it will operate equally well that way, with no change in the field or armature connections. The accompanying elementary sketches will show this to be true. Assuming that current passing through the field winding in the direction of the arrow in Fig. 1 will make the left-hand brush positive, the machine will operate that way; if it should get its residual field reversed and pick up in the opposite direction, the right-hand brush would be positive, as shown in Fig. 2, and current would be sent through the field winding in the opposite direction to the first case, as indicated by the arrow, thus maintaining the reversed polarity at the brushes.

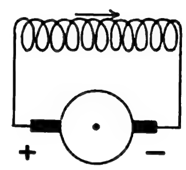


FIG. 1.

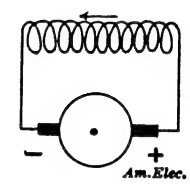
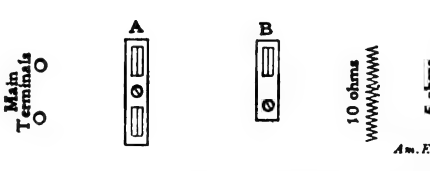


FIG. 2.

What probably happened was that in re-assembling the machine after repairing the armature damage either the brush leads or the leads to the field winding were accidentally reversed, so that the machine would not excite itself until they had been reversed back to their original relation.—Editor.]

Switch and Resistance Connections.

I should like to submit the following problem in connecting resistances: Connect the two resistances in series and obtain 15 ohms, or in multiple and get 3.33 ohms, or connect one resistance at a time so as to get 10 ohms or 5 ohms; the switches are one single-pole double-throw and one single-pole single-throw.



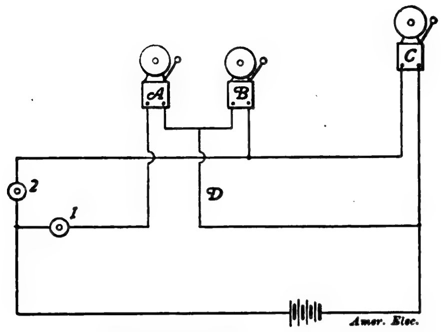
PROBLEM IN SWITCH AND RESISTANCE CONNECTIONS.

H. B. Brown.

Schenectady, N. Y.

Peculiar Bell Action.

I enclose a diagram of a case in bell work, which, although it is not a problem, might prove so to the man who encountered it in his work. The curious part of it is that the corroding of a wire causes all the bells in the house to ring in series. The bells, *A* and *B*, are together in the



PECULIAR BELL ACTION.

kitchen, while *C* is upstairs. Of course the back-door button, marked 1, should ring *A*, while the front-door button, 2, should ring *B* and *C* in multiple. The battery wire, however, has corroded off at *D*, with the result that the button 1 will ring all the bells in series.

F. B. MORTON.

Boston, Mass.

Mr. Westervelt's Insulation Test.

Find enclosed my solution to Mr. Westervelt's problem in the February issue. Apparently the difficulty is due to the grounded neutral and the exciting circuit of the wattmeter, which is between the cut-out *A* and the panel *B*. When the voltmeter is connected across the negative side of the line, and the exciting circuit of the meter connects with the positive side, there will be a

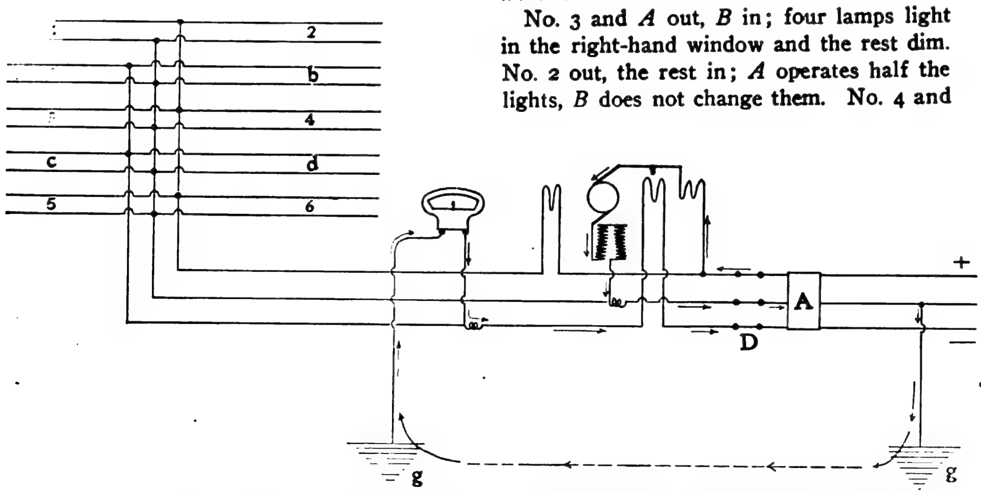


FIG. 1.—MR CARPENTER'S SOLUTION OF MR. WESTERVELT'S PROBLEM.

path through the exciting circuit of the meter and neutral to ground, to the voltmeter, then to the negative line. If the voltmeter and shunt circuit resistance could be determined the exact cause could be computed. By disconnecting the shunt of the wattmeter and renewing the test, the matter will be detected. A proof of the above is shown by having the same voltmeter reading when six of the branches are tested separately and together. This is accounted for by having six branches on the side that cause the voltmeter and wattmeter to be connected as above; the other branches will not indicate because the connection will be of such a nature as to prevent the "voltmeter-wattmeter" complication. I have experienced precisely the same trouble with a grounded neutral system.

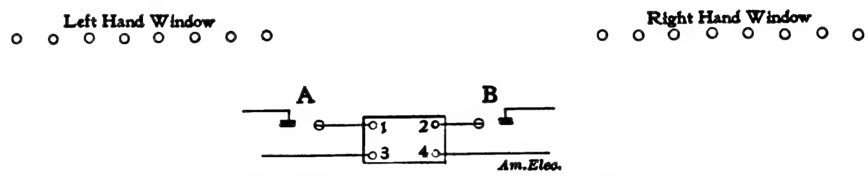
FRANK B. CARPENTER.

Birmingham, Ala.

Faulty Circuit Connections.

The following problem in misconnections may be of interest to some of your readers: Two windows, right and left-hand, are each lighted by eight lamps fed from the two ends of a double-branch plug cut-out, fused with plugs 1, 2, 3, 4, and controlled by two single-pole switches, *A* and *B*, so that normally every lamp in the two windows is turned on by each switch. The wiring was apparently in accordance with ordinary methods, but the wires from the cut-out to the windows were concealed. Nothing unusual was noticed until plug No. 4 burned out, when it was found that with switch *A* turned off and *B* on, every other light in the left-hand window burned bright, the other four in the left-hand window and all in the right-hand window burned dim, and on testing the various possibilities of switches and cut-outs, the following facts were determined:

No. 3 and *A* out, *B* in; four lamps light in the right-hand window and the rest dim. No. 2 out, the rest in; *A* operates half the lights, *B* does not change them. No. 4 and *B* out, *A* in; four lights in left-hand window lighted, the rest dim, but the bright ones are opposite from the first case. No. 3 and *B* out, *A* in; four lights in the right-hand window lighted, the rest dim, but the bright ones are opposite from the second case.



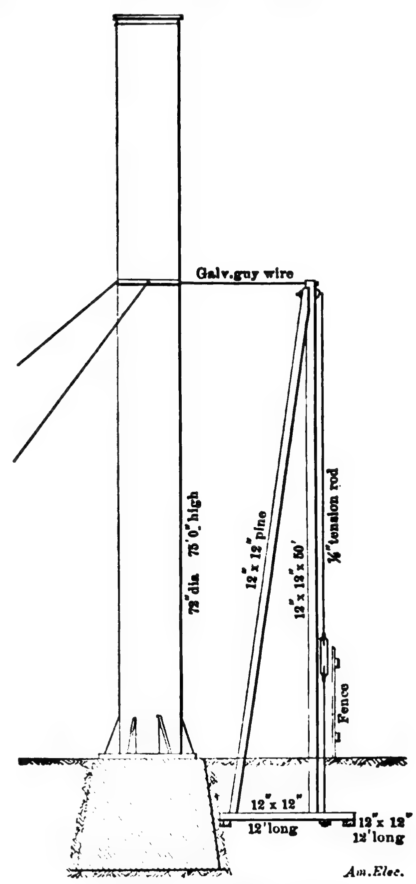
PROBLEM IN FAULTY CIRCUIT CONNECTIONS.

JOSEPH HARDWICK.

New London, Conn.

Supporting a Steel Stack.

We had erected a new battery of boilers and were about to set up the new 75-foot stack, when we found that our neighbor strenuously objected to a guy wire passing over his lot. It was pointed out to him that the guy wire would be placed well overhead, but without avail. A reasonable sum of money was then offered, but our friend would not accept thinking we would eventually be obliged to purchase his lot. While we would have bought his lot for future enlargement of the plant, still we did not want to have the guy wire affect the price, so we resorted to the arrangement shown in the accompanying sketch. We embedded two 12-foot timbers in the ground and then bolted another timber at right angles to the other two. From this latter piece we set up two 50-foot timbers coming together at the top and spread about six feet at the bottom. We ran our much-desired galvanized guy wire to the top of this structure and then put a ⅞-inch tension rod from the top to the underground horizontal timber.



SUPPORTING A STEEL STACK.

The tension was then adjusted by a turnbuckle placed at a convenient height above the ground. The arrangement was satisfactory in every way.

JOHN D. ADAMS.

Phœnix, Ariz.

Questions and Answers

Inquiries not accompanied by the name and address of the inquirer, will not receive attention.

Can a 133-cycle fan motor be changed to run on 60 cycles? W. G. B.

Not with any degree of satisfaction.

Is the Tirrell regulator adapted as well for controlling a compound-wound exciter as for a shunt-wound exciter? G. D. E.

No; because it cannot control the compounding of the field magnetism.

Is it practicable to refill dry batteries? F. W. M.

No; but they may be renewed to a considerable extent by passing current through them backwards just as you would charge a storage battery.

What other metals will behave the same as lead when placed in sulphuric acid? (2) How are lead-covered cables drawn into underground conduits? B. S.

None. (2) By means of a winch and wire rope attached to the starting end of the cable.

Is it possible for a condenser after being charged and disconnected from the charging circuit to have a higher e.m.f. across its terminals than the e.m.f. of the charging circuit? C. M. G.

No; when a condenser is charged its potential is brought up equal to that of the charging circuit.

What would be the result if the ammeters of three compound-wound generators were connected in the series mains instead of the armature main as described in Mr. Gassman's article in the February number? E. T. W.

The meters might not indicate the actual current output of the machines, but would indicate the division of current between the series windings of the different machines.

Will synchronizing lamps, or any other form of synchronizer, indicate phase differences between two machines while the two are connected in parallel? A. C. K.

No. Moreover, there cannot be any serious difference in phase between two machines connected in parallel without throwing one of them out of step and causing the circuit-breakers or fuses to blow.

In which lead from a direct-current dynamo should the circuit-breaker be connected? T. H.

With a shunt-wound machine it makes no difference; with a compound-wound dynamo, the circuit-breaker, as well as the ammeter, must be in the lead coming from the dynamo brush terminal (as distinguished from the lead coming from the free terminal of the series winding).

Can two series-wound direct-current machines of the same output and capacity be operated in series to supply double the number of lamps? (2) What are the proper connections for two single-phase transformers on a three-phase circuit? (3) How should two single-phase meters be connected to a three-phase circuit? F. D. E.

Yes. (2) Connect them up as though three transformers had been connected up in delta and one of them removed. (3) With the current coils inserted in two of the circuit leads and the potential terminals of both meters connected to the third lead.

For what can dry cells be used after they have become polarized? (2) How can a 4-volt miniature lamp best be lighted from a 110-volt direct-current circuit? A. R. T.

The best use to which they can be put is to serve as a counter e.m.f. in cases where dead resistance would ordinarily be used. See Mr. Hanchett's article in the May, 1904, number. (2) By connecting it in series with a dead resistance sufficient to take up 106 volts. The number of ohms necessary to do this may be ascertained by dividing 106 by the current which the lamp requires.

Which of the two methods shown in the accompanying diagrams (Figs. 1 and 2) is the best for connecting two lamps for two-station control? L. F. A.

Fig. 2 is preferable for the reason that each lamp is independent of the condition

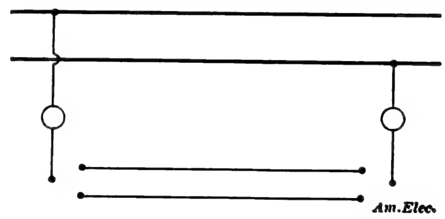


FIG. 1.

of the other one. Fig. 1 is just as good so long as the lamp sockets and filaments are in good condition, but if one of the sockets should accidentally be turned off or disabled or one of the filaments be broken it

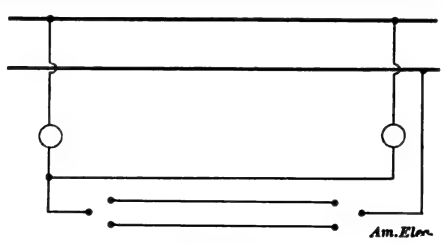


FIG. 2.

would, of course, prevent the other lamp from lighting. Moreover, in Fig. 1 the lamps must be of one-half the circuit voltage.

What is the proper timing for the igniter of a gasoline engine running at 200 r.p.m.? (2) How far from the end of the stroke should the exhaust valve begin to open? A. B. C.

With an engine running at so slow a speed the igniter would probably give the best results if set to act just as the crank reaches the dead center. (2) Your question cannot be answered without a complete knowledge of the engine and indicator cards taken from it; the point of the stroke at which the exhaust valve opens varies with different engine designs.

What size of wire and how many turns should be used for the coil of the magnetic vane voltmeter described in the December, 1903, number to make the instrument give full scale deflection at 15 volts? (2) Would the metal used in ferrotype photographic plates be suitable for the vanes? (3) Could a shunt be used with the meter for higher voltages? H. I. M.

Fifteen hundred turns of No. 22 wire. (2) Yes. (3) Shunts are used with ammeters, not with voltmeters. You can adapt the instrument for higher voltages by using dead resistance in series with it.

How should the three-pole armature of a battery motor be wound and connected up? (2) What size of wire should be used on the armature? (3) Is double cotton-covered wire preferable to single silk-covered? (4) How many feet of No. 32 German silver wire are required to get a resistance of one ohm? H. A. L.

Wind a coil on each pole, making all three coils exactly alike; connect the three inner terminals of the coils together and the three outer terminals to the segments of a three-part commutator. (2) This depends upon the size of the motor; ordinarily about No. 18. (3) Double cotton covering is preferable where space is not a vital consideration. (4) German silver wire is made in several grades. The grade known as 18 per cent alloy has a resistance of about ½ ohm per foot.

A ½-h.p. four-pole single-phase induction motor wound for 60 cycles runs at only 1400 r.p.m. and is sluggish in starting. The fields have been rewound and only two starting coils used. What is the probable trouble? (2) Can a compound-wound generator be tested for its compounding ability and a saturation curve plotted without giving it a full load? (3) Why have the Manhattan rotary converters six collector rings when they are supplied from three-phase transformers? (4) Can a rotary converter be used for electroplating, or is a motor-generator more efficient? W. H. S.

The use of two starting instead of four coils accounts for the sluggish starting of the machine, but not for the enormous slip in its speed. It is either heavily overloaded or the new winding has been connected up wrong. (2) Not satisfactorily. (3) Because the secondaries of the transformers are connected up to give six phases and the converters are built correspondingly. (4) Yes, provided wide voltage regulation is not required. The motor-generator is preferable because the voltage can be varied through a wide range; its efficiency is lower than that of a converter.

How can the internal resistance of a primary battery cell be measured? (2) Does its voltage decrease as the current output increases? (3) Does the internal resistance vary under different conditions? (4) How can the internal resistance of a battery of primary cells be made equal to the external circuit resistance, at the same time keeping the battery voltage within the ordinary limits for such work? H. M. W.

Measure the e.m.f. on open circuit with a high-resistance voltmeter; then connect the cell to a known resistance in series with an ammeter of known resistance; divide the open-circuit voltage by the ammeter reading and subtract from the result the resistance of the external circuit (including that of the ammeter, of course); the remaider will be the resistance of the battery cell. (2) The available voltage decreases because of the drop in the cell itself; the actual voltage of the cell decreases with use by reason of the gradual polarization of the cell, but this is not true of the gravity type of cell for closed circuit working. (3) It varies with changes in the electrolyte; not otherwise. (4) By designing the external circuit properly. Ordinarily there is no liability to get an impractical battery e.m.f. in trying to obtain the relation you mention; moreover, in such special cases as might tend to produce this result, it will be more economical to sacrifice the "equal resistances" idea than to pay for the battery necessary to apply it.

COMPARATIVE HEAT CONDUCTION AND RADIATION OF INSULATING VARNISHES.

BY JOHN C. DOLPH.

The necessity of providing liquid insulation for cotton covering of copper wire in coils has long been recognized, but whether the use of varnishes or compounds is really necessary, other than as a means of protection against moisture, especially in low-voltage work, has been open to discussion.

Early in 1903 the writer was impressed with the idea that the life of the coils could be greatly lengthened by increasing the natural tendency of insulating varnishes to dissipate heat either by radiation or conduction, or both. All experience up to this time had clearly demonstrated that ordinary insulating varnish was a very poor conductor of heat, and it was taken for granted that any improvement in this direction would carry with it the introduction into the varnish of material which would have a tendency to lower to the danger point the dielectric strength of the varnish coating.

With these conditions in mind the writer began a series of experiments with varnishes and compounds with the idea of treating them in such a manner as to produce a compound which would constitute an improvement over anything then in use in its ability to conduct and dissipate by radiation the heat generated in the insulation of the windings of high-potential, alternating-current apparatus. These experiments clearly demonstrated that there existed a great difference between the temperature of coils insulated with the varnish specially treated for heat radiation and conduction and the ordinary insulating varnish. To determine accurately this difference, the writer took up the matter with Dr. Sharp, of the Electrical Testing Laboratories. The following method to determine the combined heat radiation and conduction of various varnishes was followed:

A number of tin cans were provided, on the outside of each of which a layer of cloth was tightly fastened, the cloth then being painted with three coats of the varnish to be tested. Dry steam having 10° C. of superheat was then passed through each can in turn and the amount of steam condensed per minute was determined. At the same time a thermopile set up at a given distance from the can was used to determine the relative radiating powers of the surfaces which were afterwards expressed in the terms of galvanometer deflections. An uncovered tin can, as well as a can covered with soot, was provided for the purpose of comparison. These tests established beyond any question the marked superiority in point of combined heat radiation and conduction of the specially treated varnishes over the ordinary insulating varnishes. During these tests a peculiar condition developed as regards one of the clear oleo-resinous base varnishes under test. While this varnish was naturally a poor radiator of heat, owing to the nature of its surface, it proved to have gotten rid of a larger proportion of heat than any of the other varnishes tested with the exception of that treated specially for heat radiation and conduction. Inasmuch as this oleo-resinous bas varnish possessed good insulating properties, it occurred to the writer that varnishes of this description, in view of this important characteristic, were the ones which would eventually give the best results, provided they could be so treated as to develop the necessary heat radiation and conduction without the sacrifice of their high insulating properties.

It was then determined to ascertain, by electrical means, the relative combined heat conducting and radiating properties of various oleo-resinous and hydrocarbon base varnishes. There were provided eleven spools, approximately six inches in length and three inches in diameter. These spools were wound with No. 18 double cotton-covered wire, 18 layers and 108 turns to the layer, making a total of 1944 turns. In these coils were wound thermometric coils, the outside of No. 38 silk-covered wire with two turns per space, making a total of 214 turns; a middle thermometric coil of No. 40 silk-covered wire, two turns per space, with a total of 214 turns, and an inner thermometric coil of No. 40 silk-covered wire, three turns per space, making a total of 321 turns. These coils were wound on a split form so that they could be handled without the addition of insulation other than that provided by the covering of the wire and the varnish used on the coil. The wire in all cases was run through

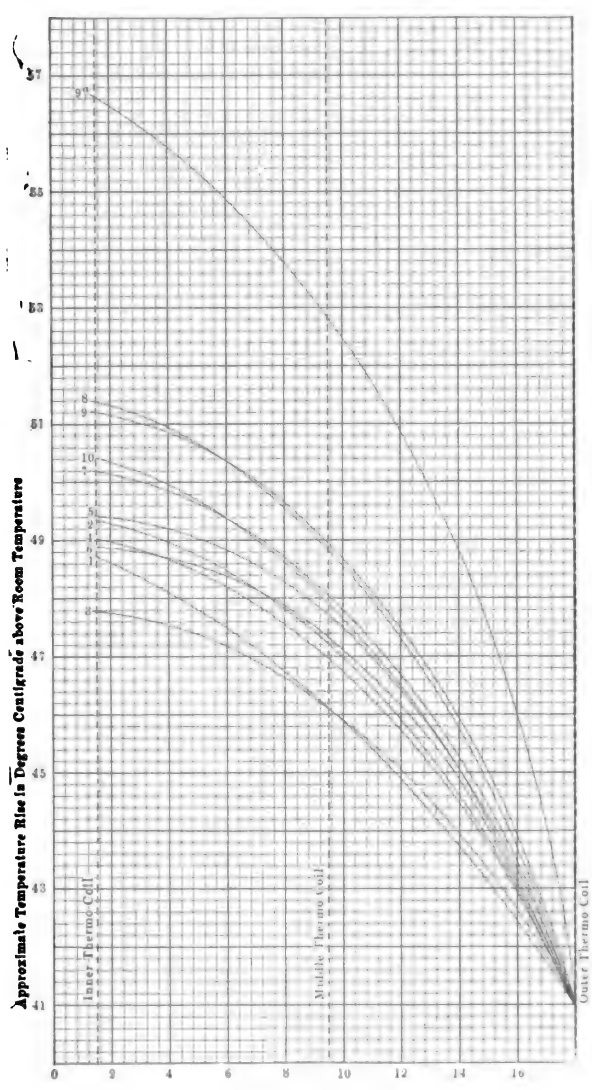


FIG. 1.—TEMPERATURE RISE DURING TEST NO. 1.

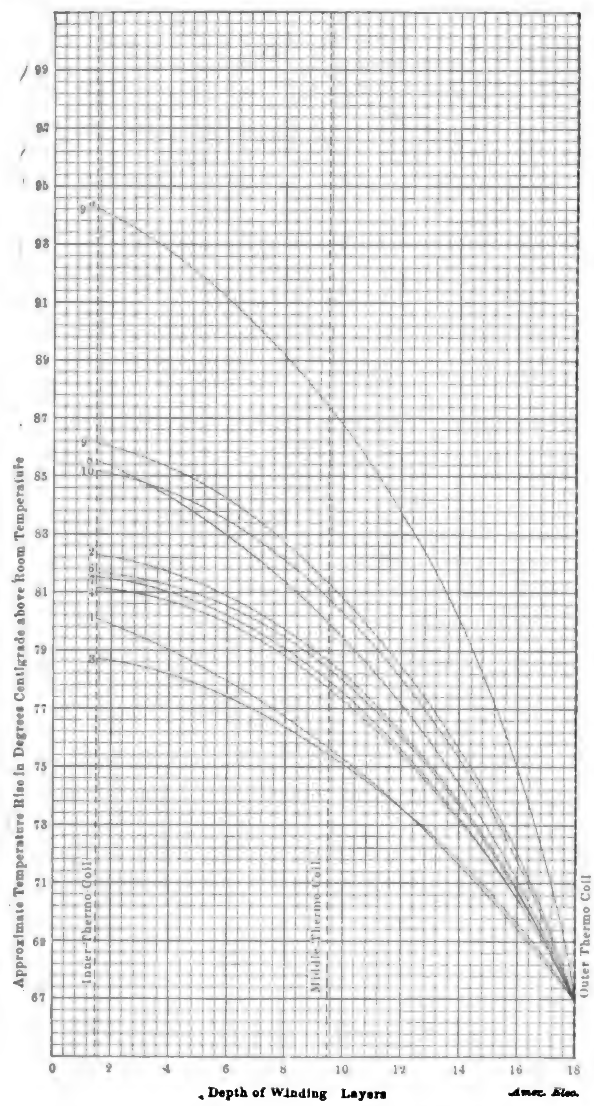


FIG. 2.—TEMPERATURE RISE DURING TEST NO. 2.

the varnish to be tested as the wire was wound on the coil. The inner thermometric coil was wound on the first layer of No. 18 wire, as of course it was not possible to wind it on the outside of the first layer.

The spools were numbered from 1 to 10, inclusive, and were treated with varnishes and compounds as follows:

No. 1 Spool—Clear, quick baking, dipping varnish of oil and gum base variety.
No. 2 Spool—Clear, baking, dipping varnish, of an oil and gum base variety.
No. 3 Spool—Heat radiating varnish, brown, dipping, baking, of a combined oleo-resinous variety, specially treated for heat radiation and conduction.
No. 4 Spool—Black, dipping varnish of an oil and hydro-carbon base variety.
No. 5 Spool—Black, solid compound of bituminous variety, liquefied under heat and used only in connection with vacuum impregnation apparatus.
No. 6 Spool—Black, brushing varnish of a combined oil and hydro-carbon base, treated for heat radiation and conduction.
No. 7 Spool—Clear, baking, dipping varnish of an oleo-resinous variety.
No. 8 Spool—Black, air drying and baking, dipping varnish of one of the hydro-carbon group.
No. 9 Spool—Black, air drying and baking, dipping varnish of a second of the hydro-carbon group.
No. 9a Spool—Untreated coil of No. 18 double cotton covered copper wire, wound up dry.
No. 10 Spool—Gray, brushing, baking varnish of an oleo-resinous variety, treated for heat radiation and conduction.

The varnishes on spools Nos. 1, 2, 3, 4 and 6 were manufactured by the Standard Varnish Works. The varnishes used on other spools were those supplied in the market in the United States and Europe for insulating purposes.

It was proposed to obtain the information desired by two similar methods.

1. Heating the spools by passing a constant current through them and getting the temperature at the inner, the outer and middle surfaces by means of the fine wire thermometric coils. (The spool showing the greatest difference between extremes would be the one from which the heat escaped most slowly.)

2. Heating the coils by passing a known constant current through them, and measuring the average rise in temperature of the spool by its increase in resistance. Under the circumstances the spool that became the hottest would be the poorest dissipator of heat.

A number of tests were made, but in the first series the current used was not sufficient to cause a temperature rise in the spools above 60° C. In the last series of tests made, as shown by the curves, sufficient current was used to carry the temperature up to, and in some cases above, that which is met with in the commercial operation of dynamos and motors in service.

The temperature rises were computed from a temperature coefficient of copper assumed to be .00383. This is based on the latest value at 0° C., approved by the A. I. E. E. (viz.: .0042), and corresponds to 23° C., the general average room temperature throughout the above tests. However, the exact value of the coefficient is unimportant, as only comparative results could be expected.

In the last test referred to the spools were all connected in series and set on end on a table in a circle, with about twelve inches of air space between spools. The air spaces in he middle of the coils were corked up at the tops, forcing nearly all of the heat to escape from the outer surfaces. The two ends of each thermometric coil were then so arranged that they could be readily connected to a Wheatstone bridge. Arrangements were provided for getting the potential across each spool rapidly at stated intervals. The observations were made as follows: First, the resistance of each thermometric coil was measured on a Wheatstone bridge; second, a known current was sent through the main coils and the fall of potential through each was noted every fifteen minutes for about three and a half hours, or until the drop became constant; third, when the temperature became constant, as indicated by the constancy of the drop, the resistance of the thermometric coils was again measured. (Precautions were taken to have the external radiation conditions the same for all spools and to avoid air drafts.)

SUMMARY OF TESTS NOS. 1, 2, 3 AND 4.

	Test No. 1		Test No. 2		Test No. 3.		Test No. 4	
Spool No.	Ratio.	Relative. order.	Ratio.	Relative. order.	Ratio.	Relative. order.	Ratio.	Relative. order.
1	.494	2	.466	2	.484	2	.465	8
2	.532	5	.545	6	.651	7	.643	6
3	.437	1	.419	1	.479	1	.456	1
4	.510	3	.506	3	.530	3	.522	3
6	.513	4	.527	5	.530	4	.530	4
7	.590	6	.520	4	.568	5	.538	5
8	.661	9	.581	7	.670	8	.663	7
9	.654	8	.685	9	.688	9	.759	9
9a	1.000	10	1.000	10	1.000	10	1.000	10
10	.603	7	.653	8	.643	6	.739	8

The table herewith gives a summary of the four tests and the curves show the temperature rise throughout the eleven treated coils and the comparative rise in the untreated coil, No. 9a.

On the diagram it will be observed that the curves have been shifted up or down, as required, to bring the temperatures at the outside to the same point for all spools. This procedure spreads the curves out more and renders the difference between them more noticeable to the eye.

It should be borne in mind that the above

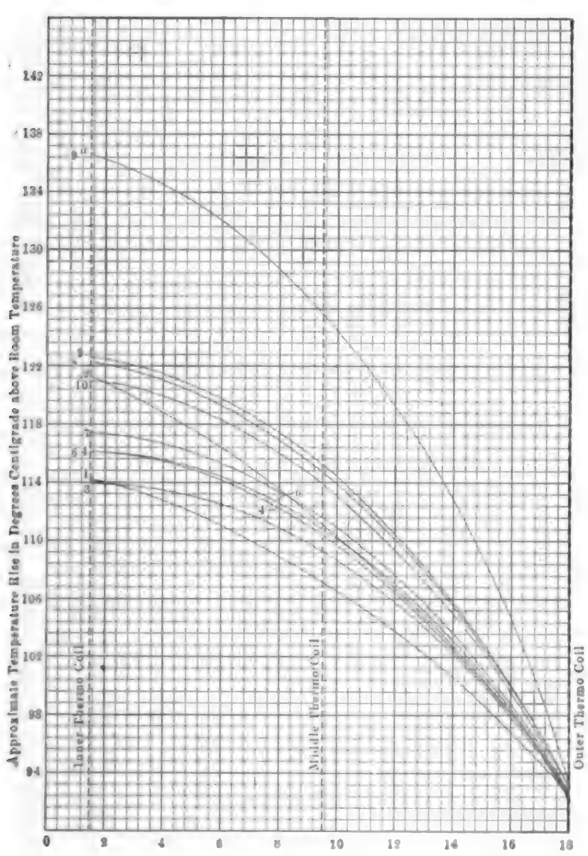


FIG. 3.—TEMPERATURE RISE DURING TEST NO. 3.

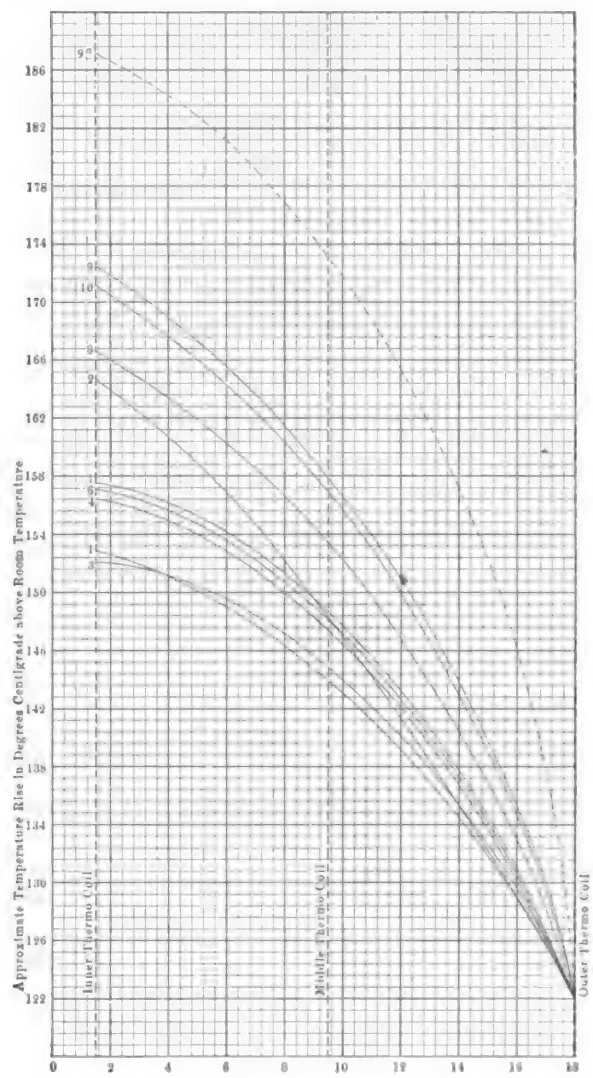


FIG. 4.—TEMPERATURE RISE DURING TEST NO. 4.

results are affected by both the heat radiating ana heat conducting properties of the compounds, hence the relative order obtained cannot be said to be due to either alone, but to the combined effects of both.

The spool No. 3, while showing among the best, is treated with a clear dipping baking varnish, which has high power of penetration, and whose insulating properties have not been affected by its special treatment for heat radiation and conduction, as will be observed by the table below, which gives the puncture test of the varnishes used on the spools in the test for heat radiation and conduction.

Spool No. 1	798	volts per mil.
Spool No. 2	783	" " "
Spool No. 3	826	" " "
Spool No. 4	703	" " "
Spool No. 5	No test made.	
Spool No. 6	917	volts per mil.
Spool No. 7	811	" " "
Spool No. 8	765	" " "
Spool No. 9	890	" " "
Spool No. 10	83	" " "

The results of the tests for heat radiation and conduction show conclusively the superiority in this respect of coils treated with insulating varni-hes or compounds over the untreated coil wound up dry.

THE KOERTING FOUR-CYCLE GAS ENGINE.

The demand for a satisfactory power to run automobiles and launches has been instrumental in accelerating the development not only of the small type of internal combustion engines used for this purpose, but also the larger types employed for the commercial generation of power. From the rapid development of these large power units it may be predicted that these engines will soon become as popular in this country as they now are in Europe.

In the Koerting four-cycle engine, shown in Fig. 3, the inspiration and compression of combustible gases and the expulsion of the burned gases are effected directly by motion of the main motor piston itself.

By reference to the sectional engravings it will be seen that when the engine piston has advanced about half way on its expansion stroke, the gas, which ignites at the instant the crank passes center, delivers its energy to the crankshaft. On the return stroke the exhaust valve is opened and the burned gases expelled. As the engine again passes center the exhaust valve is closed and the admission valve is opened, allowing a fresh charge to be drawn in. The gas and air are supplied to the mixing valve through separate regulating valves; the one being on the gas main and the other on the air line, which terminates at the hollow frame of the engine, through which the air supply is taken. This cools the metallic parts, the hollow frame also acting as a silencer for the inflowing air.

When the full charge of gas and air has been drawn into the cylinder the admission valve closes and the charge thus trapped is compressed by the returning piston to a pressure and temperature which have been found by practice to give the best economy.

As will be seen by reference to the sectional views, the cylinder and the combus-

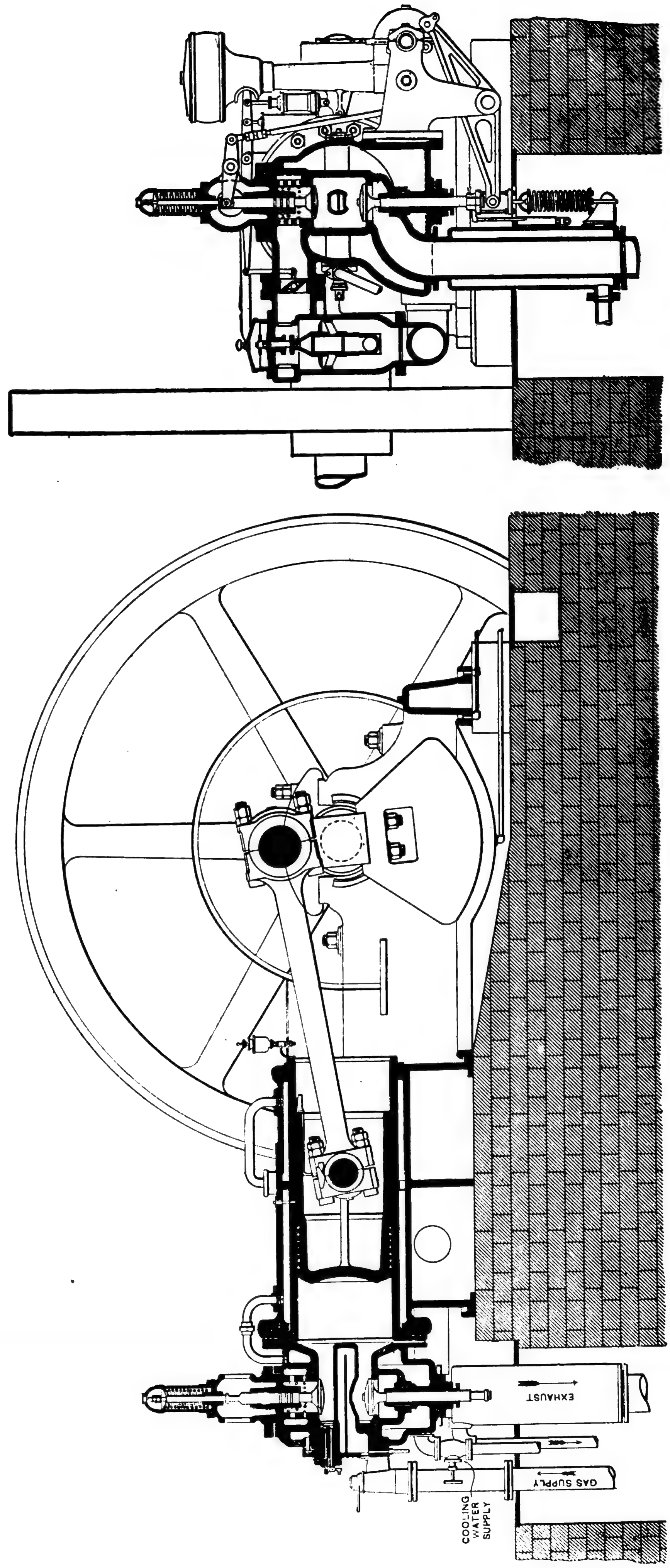


FIG. 1.—LONGITUDINAL AND TRANSVERSE SECTION OF KOERTING FOUR-STROKE CYCLE GAS ENGINE—FIG. 2.

tion chamber are water-jacketed. High economy in gas engine practice depends on the degree of compression that can be carried or the amount of gas which can be made to occupy the clearance spaces of the cylinder and combustion chamber at the beginning of stroke. On the other hand, since the temperature increases quite rapidly with the pressure, unless cooling methods are provided the degree of compression at which the richer gases will ignite spontaneously will soon be reached.

Obviously, any heat carried away by the cooling water is lost, so that no more cooling should be done than is absolutely necessary to admit of the desired compression. This engine is said to owe much of its economy to the design of these water-cooling chambers.

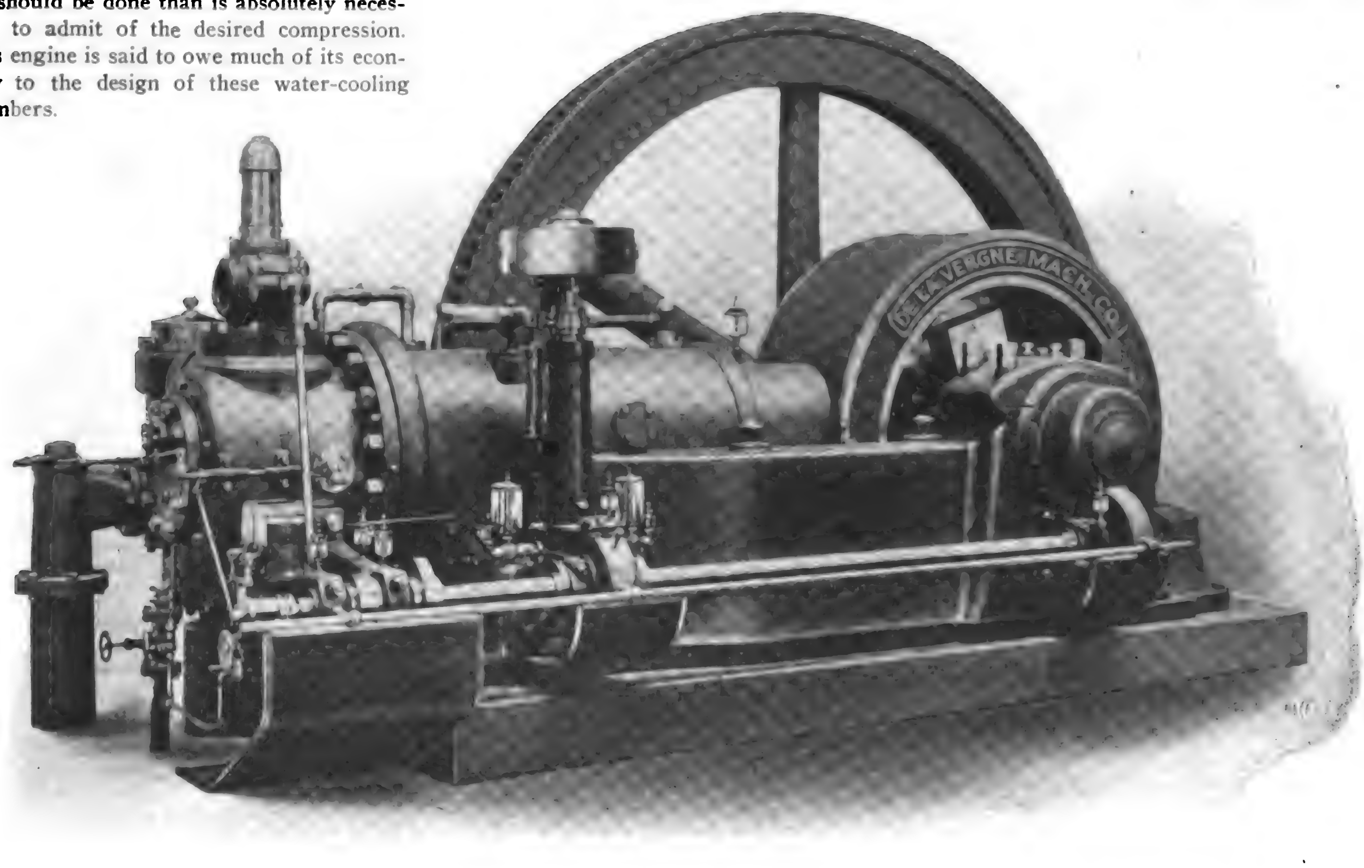


FIG. 3.—KOERTING FOUR-STROKE CYCLE GAS ENGINE.

Rich gases ignite at a much lower temperature than the "leaner" ones. For the same cooling effect compression of the former gas cannot be carried as high as that of the latter and for the same degree of compression a greater cooling effect is necessary in the former case than in the latter.

Ignition is effected in both the four and the two-cycle engine by means of magnetos, the leads from which terminate in an igniting plug inserted in the cylinder head. These plugs when pushed home seat on an asbestos gasket and are secured by four studs. The stationary rod which forms one terminal of the magneto is insulated from the metallic portion of the plug by two tapered porcelain plugs. The movable rod, which forms the other terminal of the magneto, is free to turn in its bushings and is actuated by the valve mechanism. The mechanism which drives the magneto is so arranged that the armature is first turned slowly through about one-third of a revolution against a spring. At the instant the charge is to be ignited the magneto lever is disengaged and the spring gives the magneto armature a quick jerk back to its original position, sending an electrical impulse through the igniting plug terminals, which break contact at the proper instant, thus igniting the charge. In the larger size engines two igniters are operated in unison and the large charges being ignited at two points insure uniform combustion.

One of the main features of design to which this engine is claimed to owe its superiority over many other types is the perfect symmetry of cylinder construction. It will be noted that the cylinder barrel has no lugs or projections of any kind cast on its surface, a fact which insures perfect rectilinear expansion under all conditions of temperature. The cylinder barrel is held in position by the main cylinder stud bolts, which also secure the combustion chamber and head to the main frame. The main engine frame is of unusually solid design, completely surrounding the motor cylinder barrel and supporting it at both ends and in the middle in such a way as to form a concentric water jacket. Since the motor cylinder barrel is secured longitudinally only at the head it is perfectly free to expand and contract with every change in temperature.

The water coming from the jackets is used in cooling the exhaust gas either by means of a water jacket on the exhaust pipe or by direct injection into the exhaust pipe. The cooling of the gas having the effect of reducing its volume, tends to silence the exhaust and reduce the back pressure on the machine.

Tests made on the Koerting four-cycle engine with gas of about 500 B.T.U. per cu. ft. gave thermal efficiencies per brake horse-power of 28.22 per cent., 29.05 per cent., 29.23 per cent. and 31.96 per cent.

The popularity of the engine in Europe is shown by the fact that in the past four years over four thousand have been put into operation. These engines are built in the United States by the De La Vergne Machine Company, of New York, which company has the exclusive right to manufacture and sell these engines, as well as the Koerting two-cycle, double-acting engine. This company has erected for the Lackawanna Steel Company, of Buffalo, the largest single gas engine installation in the world. This plant when completed will aggregate 40,000 horse-power, 32,000 of which will be occupied in operating blowing engines and 8,000 in driving direct-connected generators, three of which are 500-kw, 250-volt, direct-current Sprague dynamos and five of which are 500-kw, 440-volt, three-phase, 25-cycle General Electric dynamos.

COPPER LEADING-IN WIRES FOR INCANDESCENT LAMPS.

Ever since the first practical incandescent lamp was made, it has been the fixed conviction of the electrical engineering fraternity that leading-in wires of any metal except platinum were absolutely hopeless, and the industry has gone along on that basis, facing a constantly decreasing supply of platinum which has increased its price something like 100 per cent. If present indications prove accurate, this bugbear has been demolished by an extremely simple expedient which appears to make it thoroughly practical to use copper instead of

platinum for the leading-in conductors; this expedient consists in forming each wire into a circle where it is enclosed in the glass mount, with the entering and emerging straight-line part of the wire joining the circle at diametrically opposite points, as shown in the accompanying illustration. There are no joints, however, the complete conductor being formed from a single piece of wire. The conductor in the circular part is extremely attenuated by the die which forms it into that shape, but since copper

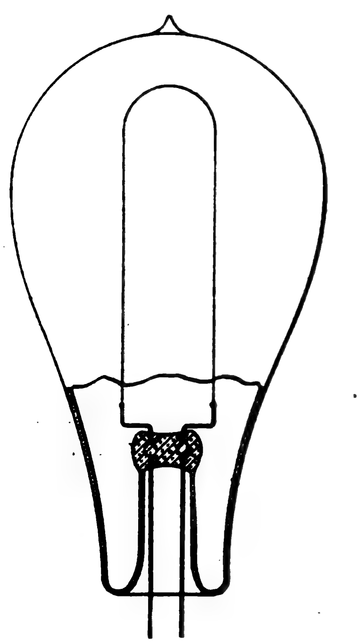


FIG. I.—INCANDESCENT LAMP WITH COPPER LEADING-IN WIRES.

has a much higher conductivity than platinum, the smallest cross-section that can be handled in the course of manufacture without excessive breakage is ample to carry the current for a 32-c.p., 110-volt lamp. Consequently, the same leading-in wires would be used in practice for 32-c.p. and all other lamps of lower candle-power at 110 volts, and for all 220-volt lamps up to 50 candle-power.

This form of leading-in wire was invented by Mr. John H. Guest, who is widely known in electrical circles as one of the pioneers in the electric lighting and railway fields. Mr. Guest was, in fact, one of the very earliest workers in the realm of incandescent lighting, having been a contemporary of Edison, Maxim, Sawyer and the other investigators of the problem in the early eighties. He has taken out a number of patents, some of his lamp patents dating back to 1879 and 1880, and all of which indicate the fertility and originality of the typical inventor and investigator of scientific problems.

Of course, "the proof of the pudding is in the eating of it," and it is rash to make any predictions as to the ultimate fate of a development of this character; its permanent value can be determined only by a time test after the details of manufacture have been perfected and standardized. But it is of interest to note that two lamps equipped with the Guest copper leading-in wires have been burning at full candle-power in this office, all day and every day except Sunday, since March 20.

MURRAY ENGINE FOR HEAVY DUTY.

The Murray Iron Works Company, Burlington, Ia., some time ago brought out a "rolling mill" type of engine designed for high steam pressures and high speeds, and therefore especially well adapted to electric lighting and power service. Fig. 1 illustrates the general form of the bed and guide housing, which are cast in a single piece. The cylinder is, of course, bolted to the rear end of the guide housing, and the latter

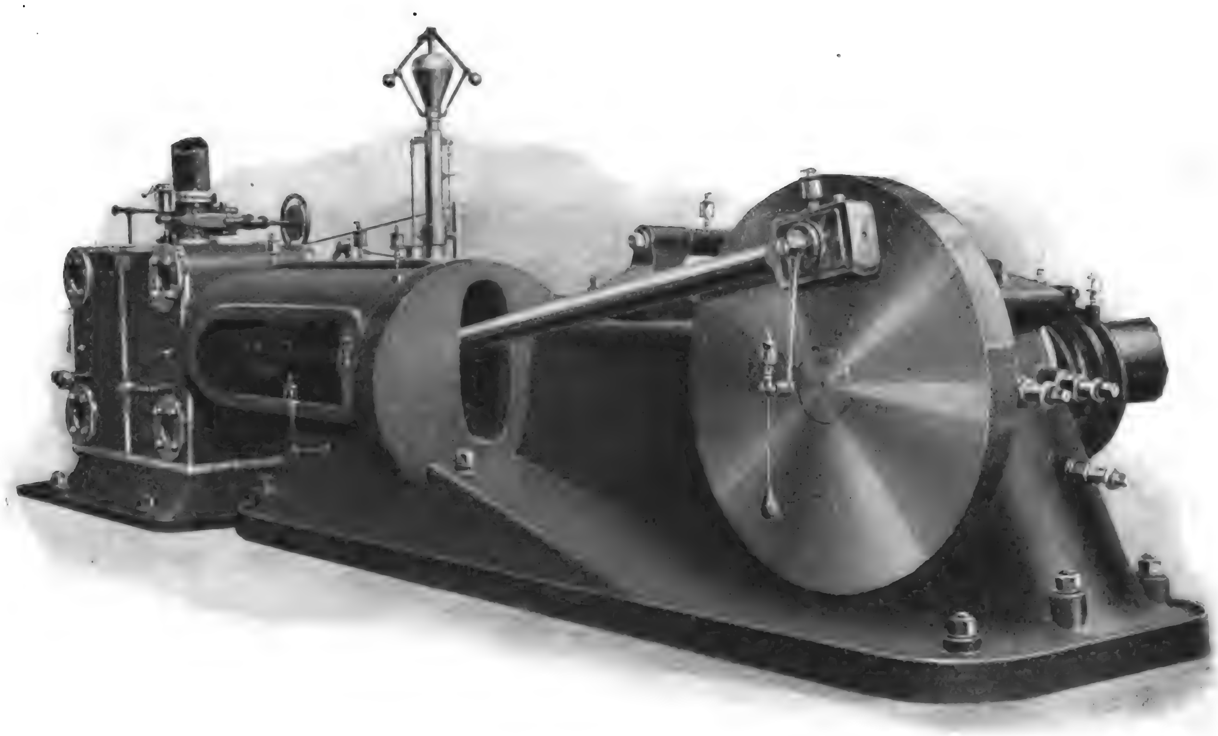


FIG. I.—MURRAY HEAVY DUTY CORLISS ENGINE.

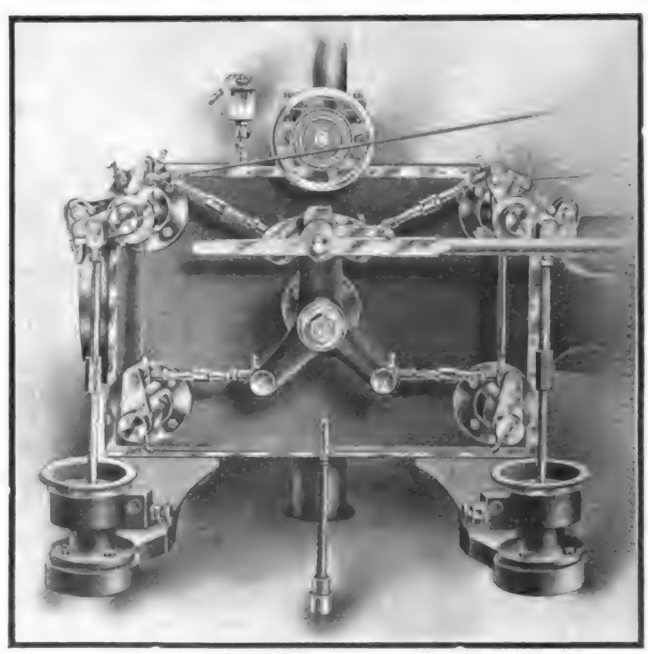


FIG. 3.—VIEW OF VALVE GEAR.

is supported solidly by the bed throughout the whole length of the guides; the advantages of this feature are obvious.

The cylinder is cast with a wide air space between the barrel and the exhaust chest,

so that the temperature of the cylinder barrel is not affected by contact with the low-temperature exhaust steam. This is shown in Fig. 2, which is a longitudinal section

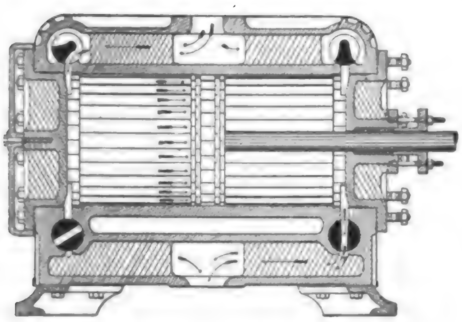


FIG. 2.—SECTIONAL VIEW OF CYLINDER AND STEAM CHEST.

through the cylinder, steam and exhaust chests, valves and valve chambers. This view also shows that the form of valve used differs importantly from the conven-

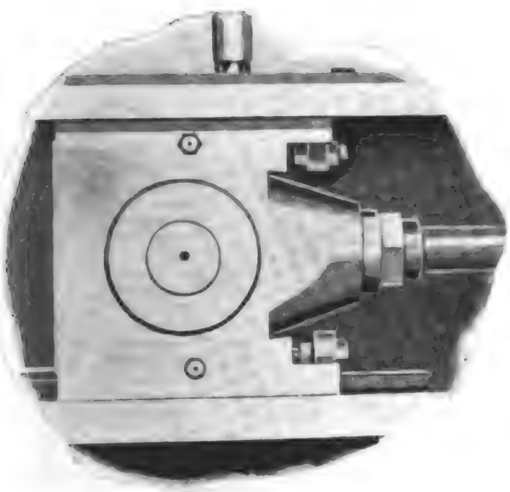


FIG. 5.—CROSS-HEAD.

tional type used by many of the old builders of Corliss engines. The steam valves open away from the incoming steam and are driven by T-head valve spindles, leaving them free to seat themseles accurately. The exhaust valves have through ports instead of being merely cut away on one side, and they are consequently well balanced, the stationary ports in the walls of each valve chamber being diametrically opposite each other.

The cylinder is provided with massive feet, two of which project sufficiently to form seats for the two dash-pots of the steam valve gear, as shown clearly in Fig. 3. The dash-pots are remarkably simple and effective. Fig. 4 shows a sectional elevation of the type used on engines of medium and large sizes. The plunger is of the double diameter type, the smaller part of it serving as a guide and also as the "sucker" to draw the valve arm down. The large part cushions the mechanism on the body of air drawn in the chamber beneath it on the up-

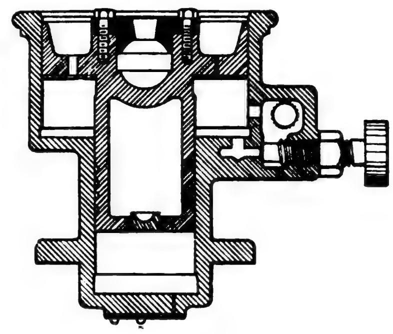


FIG. 4.—DASH-POT.

ward motion; the cushioning is regulated by means of the valve at the right of the illustration. The plunger is attached to the drop rod by means of a ball-and-socket joint so as to allow perfect freedom and self-alignment. The pot is finished all over, and as the seats on the cylinder feet are finished true with the bore of the valve chambers, the dash-pots come true with the valve gear when bolted to their seats.

The valve gear (shown in Fig. 3) and the governor are familiar to all readers of this paper, having been fully described in the general description of American engines published in our June, 1903, number and being in wide use throughout the United States.

The cross-head employed on all Murray engines is illustrated by Figs. 5, 6 and 7, and is a particularly strong feature. It is box-shaped and heavily tapered top and bottom, where it fits the edges of the shoes, the latter being of a sort of channel iron cross-section, as indicated in Fig. 7, and provided with adjusting screws and nuts as shown in Figs. 5 and 6. This construc-

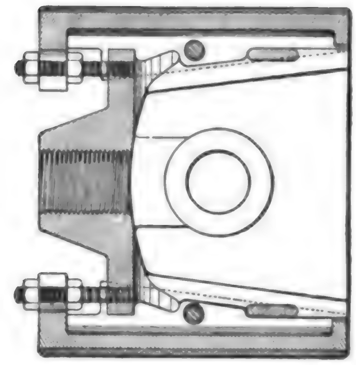


FIG. 6.—CROSS-HEAD.

tion permits the use of a very heavy neck to receive the end of the piston rod, as may be seen by inspection of Fig. 6, which eliminates liability to failure at this point. The rod is screwed into the cross-head, a

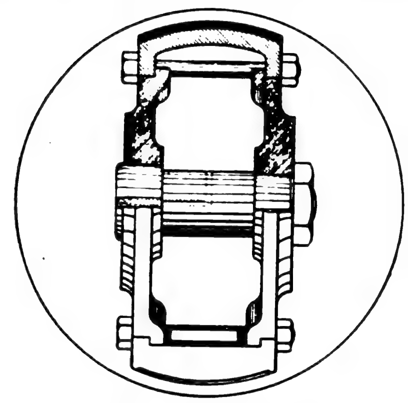


FIG. 7.—CROSS-HEAD.

heavy thread being used which is practically equal in strength to the solid part of the rod. The construction just described also allows the use of a cross-head pin supported at the ends without involving excessive weight or clumsiness of parts. The guides are bored concentric with the cylinder seat, and the cross-head shoes are, of course, turned to fit the guide bore.

For very large high-speed engines, the

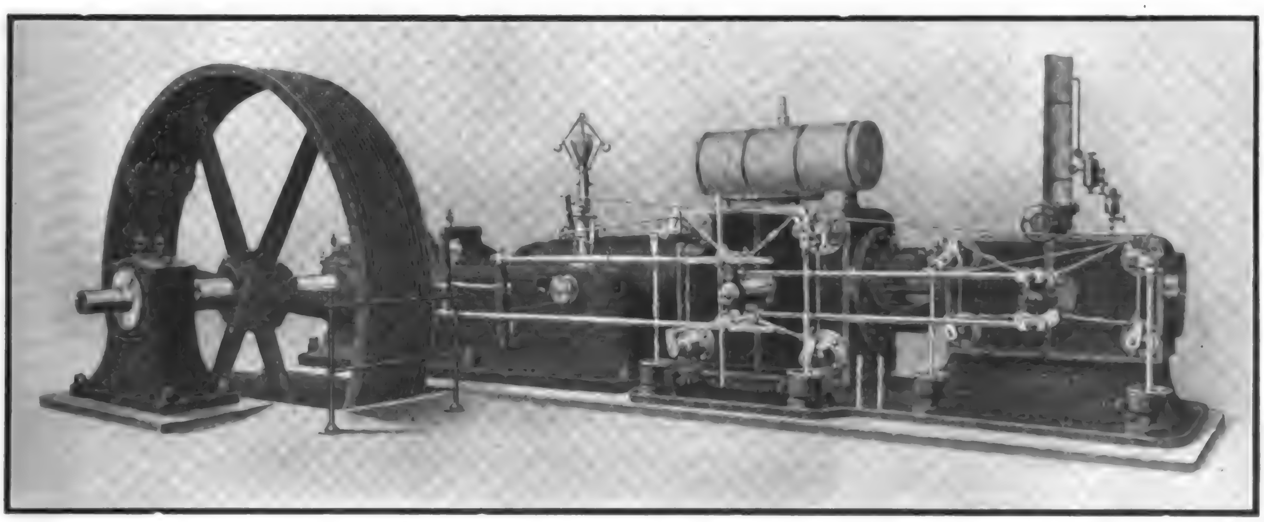


FIG. 10.—MURRAY TANDEM-COMPOUND CORLISS ENGINE.

double-ported valves illustrated in Fig. 8 are used, giving large port openings with small valves and short valve travel. On direct-connected engines, the main bearings are provided with the wedge adjustment shown in Fig. 9, in order to facilitate centering the generator armature in its field magnet. The engraving is self-explanatory.

These engines are built, of course, in cross and tandem compound forms and with either single-eccentric or double-eccentric valve gear, according to the requirements of the purchaser. Fig. 10 illustrates a tandem compound with double-eccentric valve gear and a grooved fly-wheel for rope

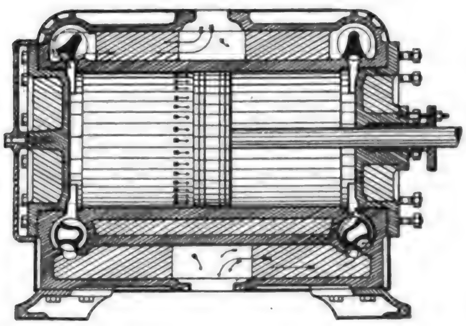


FIG. 8.—SECTIONAL VIEW OF HIGH-SPEED CYLINDER AND STEAM CHEST.

drive. The intermediate receiver is mounted on the low-pressure cylinder, but this, of course, is a detail susceptible to much variation. The arrangement of the cylinder feet and dash-pots of the two cylinders is the same as that of the single-cylinder engine just described. The high-pressure cylinder is bolted to the low-pressure cylinder through a cylindrical distance piece, the flanges of which are of the same diameters as the cylinders themselves, and the rear cylinder is mounted on guides which allow it to slide in response to the expansion and contraction of the structure.

MERCURY VAPOR CONVERTER.

A 30-ampere mercury vapor converter for changing single-phase alternating current of 60 cycles to 120-volt direct current is shown by Fig. 1 herewith.

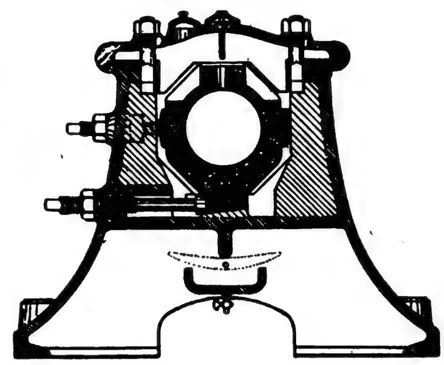


FIG. 9.—MAIN BEARING FOR DIRECT-CONNECTED MURRAY ENGINE.

The apparatus illustrated, which is made by the Cooper Hewitt Electric Company, of New York City, consists of a glass bulb about 9 ins. in diameter enclosed and mounted in a suitable holder. A small switchboard is mounted on the front, on which are placed a direct-current ammeter and a voltmeter, two switches and a current regulator. No special care is necessary in its manipulation, since there are but few moving parts, with little or no chance of these getting out of order. As compared with a motor-generator set, the cost of the converter is less and its efficiency greater. The outfit is automatic in its action, starting with the closing of the alternating and direct-current circuits. The apparatus may also be rendered non-automatic by the opening of a switch.

With alternating-current voltages not exceeding 450 volts, an autotransformer is used to obtain the proper potential for operating the converter. On higher voltages a transformer with separate primary and secondary is used. The maximum capacity of the converter is 30 amperes continuous running, and the current is adjustable as low as six amperes. The converter may be adapted to any direct-current voltage up to 120 volts.

The converter itself has a number of interesting characteristics. Its vacuum is similar to that of the mercury vapor lamp; but since it is not intended to give light, its length is as short as possible. The voltage across the converter, which represents its total resistance, is therefore reduced to 10 or 15 volts. As in the mercury vapor lamp this voltage is practically constant regardless of current except where this is small. With large currents in the container a considerable amount of heat is developed within the enclosing chamber, which must be dissipated. The container itself must therefore be made of considerable size to get the proper cooling surface. The mercury of the negative electrode is evaporated during the operation, and condenses on the surface, flowing back again to the electrode.

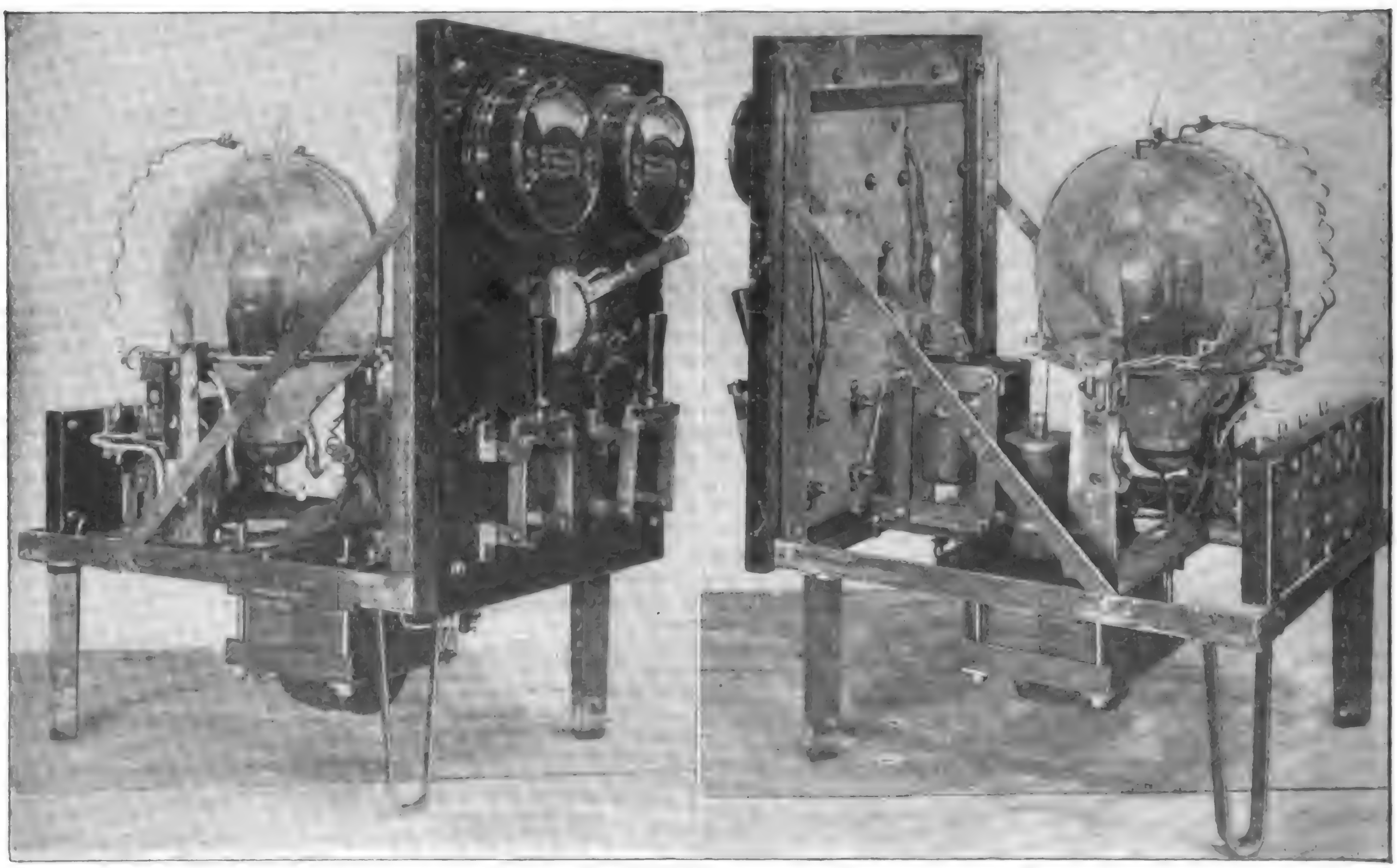


FIG. 1.—FRONT AND REAR VIEWS OF COOPER HEWITT MERCURY VAPOR CONVERTER.

New Apparatus and Appliances

QUEEN STAND PIPE RHEOSTATS.

Queen & Co., of Philadelphia, Pa., have recently designed a series of rheostats consisting of a continuous length of wire wound spirally on an iron stand pipe, about 6 inches in diameter, of a length depending on the total resistance and the current carrying capacity required. The wire is insulated from the iron pipe to withstand an alternating potential of 1000 volts. The pipe is closed at the bottom and by means of a small pipe, on either side of the base, a stream of water can be introduced for cooling purposes. If the rheostats are not used at their maximum capacity, water is not necessary; when only used at their maximum capacity for a few minutes at a time the pipe filled with water, alone, is sufficient; running water is recommended only when the rheostats will have hard continuous service at their maximum rated capacity. The stand pipe is mounted on a hardwood base, provided with casters, so as to be easily moved about. Mounted parallel to the upright pipe is an angle iron guide, which carries a slider, to which are attached phosphor bronze springs, which, in turn, make contact against the wire on the pipe. All the parts are insulated except a rod in the center of the angle iron guides, which is connected with the phosphor bronze springs by means of a split brass sleeve in the wooden handle. This allows adjustments of the current by almost infinitesimal steps.

FIG. 1.—STAND PIPE RHEOSTAT.

These rheostats are recommended by the builders for laboratory work in electrolysis, where it is necessary to secure fine graduations of both current and potential. To secure a potential regulation, the rheostat is supplied with two sliders, the terminals of the main conductor are connected with the main current source and the wires to the apparatus are connected to the two sliders. By putting the sliders close together, the difference of potential is very small, whereas, by sliding them farther apart, it can be increased to any desired point. The rheostats are made in several sizes.

GAS ENGINE DRIVEN GENERATOR.

The Rochester Electric Motor Company, of Rochester, N. Y., has brought out a line of machines especially designed for gas engine drive, one of which is illustrated by Fig. 2 herewith. The frame is of cast iron and unusually heavy, and in all but the smaller sizes the poles are built up of punchings of annealed sheet steel. The armature core is built of thin, carefully annealed discs, mounted directly upon and firmly keyed to the shaft, which is of large diameter and properly proportioned to safely carry the flywheel without any outboard bearing. Carbon brushes are used. The bearings are of phosphor bronze, self-aligning, and provided with ring oilers, which feed the oil to spiral grooves. Reservoirs of ample capacity are provided with overflow gauges. Shields or grooves upon the shaft return all surplus oil to the reservoirs. The dynamos may be operated either as compound-wound, constant potential machines for lighting, or as shunt-wound, variable potential machines for charging batteries by making the proper connections at the switchboard. The machines are built in sizes ranging from .8 kilowatt to 20 kilowatts, with speeds from 1400 to 950 r.p.m., and for e.m.f.'s of 115, 230 and 500 volts.

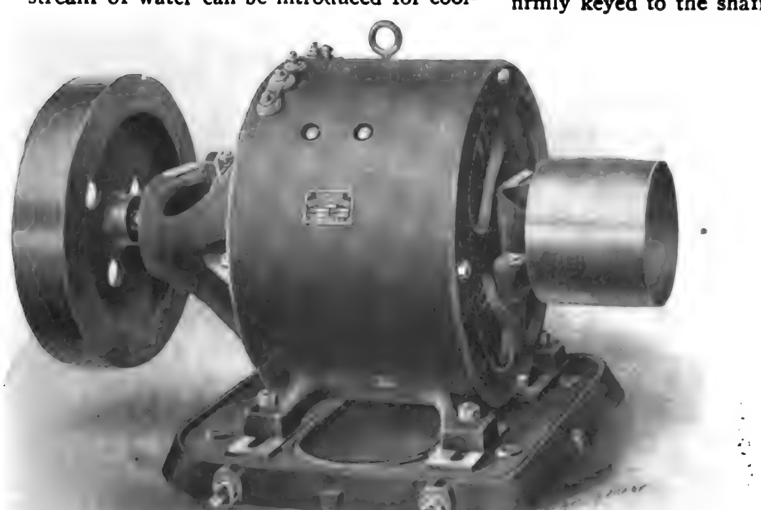


FIG. 2.—GENERATOR FOR GAS ENGINE DRIVE.

NEW RECEPTACLE AND ATTACHMENT PLUGS.

H. T. Paiste Co., Philadelphia, has just placed on the market a new style of its Fielding receptacles which is adapted for 3-wire molding. The problem for a long time has been to design this so that, although the receptacle was to be wired alternately on the negative and positive wires of the 3-wire system, in each case the lamp opening should be central with the line of molding. By an application of the Fielding receptacle principle the company has succeeeded in doing this and has ready for the market the receptacle shown by Fig. 3. After the receptacle is wired on either of the outside wires, it is simply turned end for end and it is then wired on the other one. The company has also put out a new line of "P-K" attachment plugs for 1905. These include a new style of the well-known brass-cap type, with a cap to take standard lamp-cord. The full line now includes brass-cap for standard lamp-cord, brass-cap for re-inforced lamp-cord and porcelain cap.

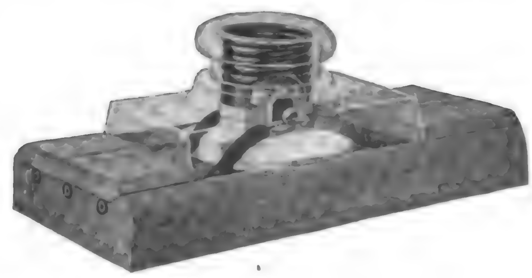


FIG. 3.—MOULDING RECEPTACLE.

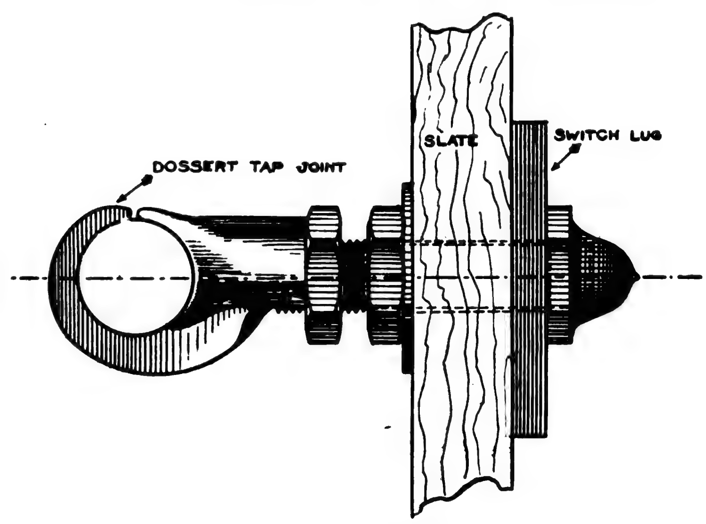


FIG. 4.—BUS-BAR SUPPORT.

DOSSERT BUS-BAR SUPPORT.

Dossert & Co., New York, have added to their line of solderless electrical connectors a bus-bar support for use in connection with round busses. The support, which is shown

in Fig. 4, is a modification of their standard cable tap. The principal member of the device is a substantial hook-shaped piece, machined to fit the bus-bar. A suitably shaped casting, which fits in the space between the bar and the base of the hook, and which is brought up snugly by means of a nut, holds the bus-bar securely in place. The shank of the hook is extended to form a stud long enough to pass through the board and the switch lug. The support is held in place in the usual manner by means of nuts on the front and back of the board. The manufacturers also make a support of similar character, but having the stud integral with the switch lug.

WESTINGHOUSE "TYPE R" DIRECT-CURRENT BIPOLAR MOTORS.

A line of direct-current motors known as "Type R" has been produced by the Westinghouse Electric & Manufacturing Company. These are constructed in sizes from one-sixth to one and three-quarter horsepower and wound for 110 and 220 volts. The fields are shunt-wound. The yoke, brackets and poles are cast in one piece. The bore of the bearing housing supports is the same as that of the field poles. Accordingly, the armature can be removed by simply taking out one bearing housing and this may be done without removing the pinion or pulley, unless it is larger in diameter than the bore of the field poles. The front end bracket is formed by three arms, which afford protection to the commutator, but leave openings through which ready access to the brushes may be obtained. The two poles project inward in a horizontal plane and are magnetized by machine-formed coils. These coils are treated with both a weatherproof and an insulating compound, and are covered with a number of thicknesses of tape to guard against mechanical injury. The coil supports are small L-shaped pieces of sheet brass which are fastened to the poles by screws and which hold the coils firmly in place. The bearings are of the ring self-oiling type, with linings of phosphor-bronze, mounted in separate housings which may be adjusted in any position, so that the oil reservoirs hang vertical whether the motor be set upon the floor or suspended from the wall or ceiling. Creeping of oil along the shaft is prevented by the use of a properly designed oil-thrower or wiper which protects the commutator and armature. The oil reservoirs are of ample capacity and the oil rings are easy to inspect, as they may be seen from the opening in the bearing housing. The motors are usually furnished without bed-plates, but may be supplied with bed-plates of the universal type, equipped with drip-pans and belt-tighteners and arranged for wall or ceiling suspension as well as for floor mounting. The armatures are of the slotted drum type with imbedded coils which are

FIG. 5.—PARTS OF WESTINGHOUSE TYPE R MOTOR.

retained in the slots by hard fibre wedges, without band wires of any kind. The armature cores are formed of circular punchings of carefully annealed soft steel. They are mounted upon shafts which are so designed that pulleys or pinions may be secured with keys. The leads to the commutator are adequately protected by a covering of treated cloth and tape. The brush-holder arms are mounted upon rings which are supported at three points inside the motor frame. The individual holders are of the sliding type with the rod construction. Pressure on the brush is exerted by a coiled spring. The carbons are said to be held radial at all times, there being no swivel action, it is claimed, during the operation of the machine. The commutators are built up of hard-drawn copper bars assembled upon brass bushes. They are made without necks. The terminals are of the brass bolt and nut construction and are located on the two lower arms of the front end brackets. The bolt or stud is threaded on both ends and is brought through insulated bushings and clamped into position by a nut on either side of the arm. These nuts are properly insulated by vulcabeston washers. Another nut on either end of the stud serves to fasten the leads. No porcelain is used in the construction of these terminals. They are easily accessible and are largely protected from accidental short-circuit or other injury by their position. The starting rheostats furnished with these motors are of approved design, with automatic no-voltage release. They are small and compact and fireproof throughout. The resistance is of the bar-wound type with porcelain insulation to ground, and is thoroughly ventilated. The adjustment is said to be such that the motor starts without jar or abnormal rush of current.

THE BEST PATENT ADJUSTABLE WEDGE GATE VALVE.

Fig. 6 herewith shows the patent adjustable wedge gate valve made by the Best Manufacturing Company, of Pittsburg, Pa., and used in many of the large power houses. The sectional view shows the wedge in the same form as the solid taper wedge, except that it is in two parts, there being a ball joint on the inner surfaces the entire circumference of the wedges. The manufacturer claims the valve to be positive seating and adjustable. The wear can be taken up from time to time and the renewable feature is said to make the valve very

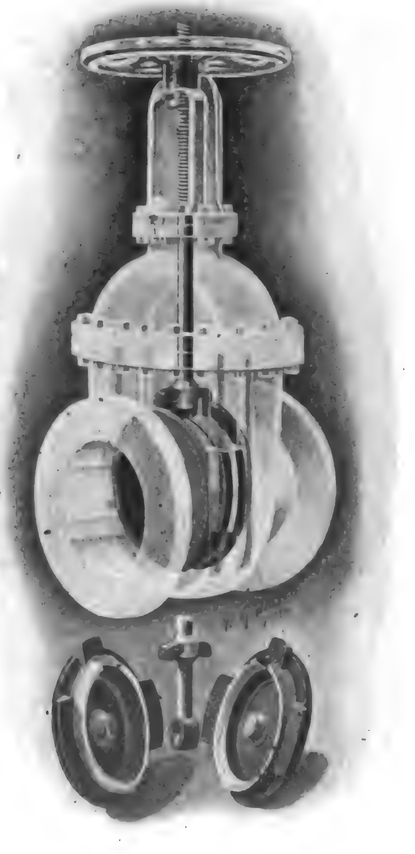


FIG. 6.—ADJUSTABLE WEDGE GATE VALVE.

durable. Rails or guides are cast in the body on either side, and wings are cast on either side of the wedges which fit inside of these guides or rails. This precludes the possibility of the valve becoming disarranged. It will be noted that there are

wings cast on the top edges of the wedges, and also a collar with guides, cast on the spindle. The valves are said to be so constucted that they have no more parts than

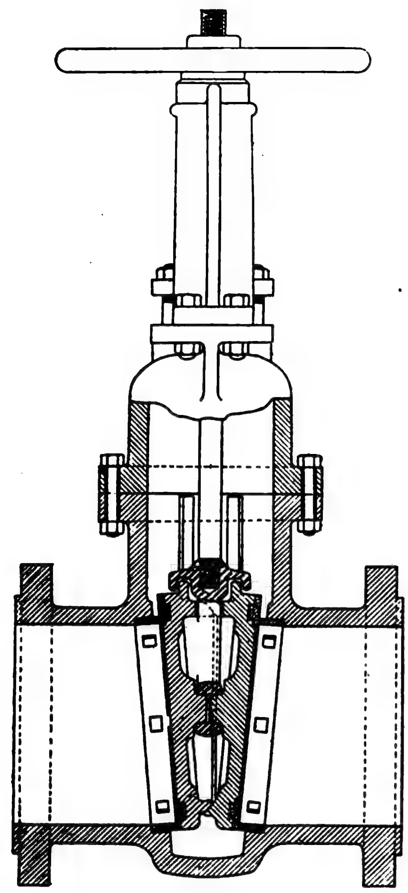


FIG. 7.—SECTIONAL VIEW OF GATE VALVE.

a solid taper wedge gate. The wedges have bronze facings; and the bronze seats are claimed to be screwed up in such a manner as to leave no pockets in the rear for the water and steam to attack the threads. The method of seat construction avoids some very bad features existing in gate valves. The mechanical construction of the valves, the manufacturer maintains, makes them especially fitted for all classes of service, particularly high pressure and superheated steam service.

A COMPACT GENERATING SET.

The B. F. Sturtevant Company, Boston, Mass., has brought out for torpedo boat service and similar duty the small generating set illustrated herewith. It comprises a single-cylinder engine and direct-current generator, standing less than 30 inches high and having an output of 3 kilowatts. The engine cylinder, which is 3½ inches diameter by 3 inches stroke, is cast with the frame. The reciprocating parts are completely enclosed, but are readily accessible through an opening which is normally covered by a removable plate. The main bearing measures 1 7-16 inches diameter by 3⅛ inches in length. A balanced piston valve controls the steam distribution, and is operated by a Shepherd governor attached to the flywheel and giving a regulation of 1½ per cent. from full load to no load. The cross-head is of the slipper type adjustable for wear and provided with a pin ¾ inches diameter by 1½ inches long. A forked end connecting rod and a 1¼-inch by 1½-inch crank-pin are employed. Designed for extremely high-speed and continuous service, this engine has proved remarkably quiet in operation, and particularly suited to modern yacht and similar service.

The generator is of the four-pole type, designed to run at full output continuously, and embodies the best features of modern dynamo construction. The current densities are low, and ample ventilating ducts are provided. The machine is compound-wound, and capable of carrying 50 per cent overload for short periods of time without shifting of brushes or flashing at the commutator. It will carry a continuous overload of 25 per cent without undue heating or sparking. After a continuous run of ten hours at full load, the increase in temperature above that of the surrounding atmosphere is guaranteed not to exceed 40° Centigrade in any of its parts. The insulation is of the best. It is subjected to a test e.m.f. of at least 1500 volts for a period of one minute before being shipped, the insulation resistance as measured by a voltmeter, not being allowed to fall below 1 megohm. The magnet frame is of steel parted horizontally and has removable magnet poles of wrought iron with cast-iron shoes. The poles are attached to the magnet frame by through bolts, and each pole carries a shunt and a series coil.

The armature is of the slotted-core ventilated drum type, having a core of special low steel or charcoal iron mounted upon a cast iron spider which has a hub extension for the support of the commutator which is constructed of drawn copper segments, held in a cast-iron shell of spider construction and clamped with a steel ring. Only the best and most carefully selected mica is used between the segments. The end insulation consists of micanite rings. The coils are form-wound and individually insulated. The brush-holders are of the box type, and are mounted upon studs supported from the brush arm. Each brush and holder is separately adjustable and readily removable for cleaning and repairs.

HIGH-TENSION STRAIN INSULATORS.

Two forms of high-tension strain insulator are shown by Figs. 9 and 10 herewith. These are made by the Locke Insulator Manufacturing Company, of Victor, N.

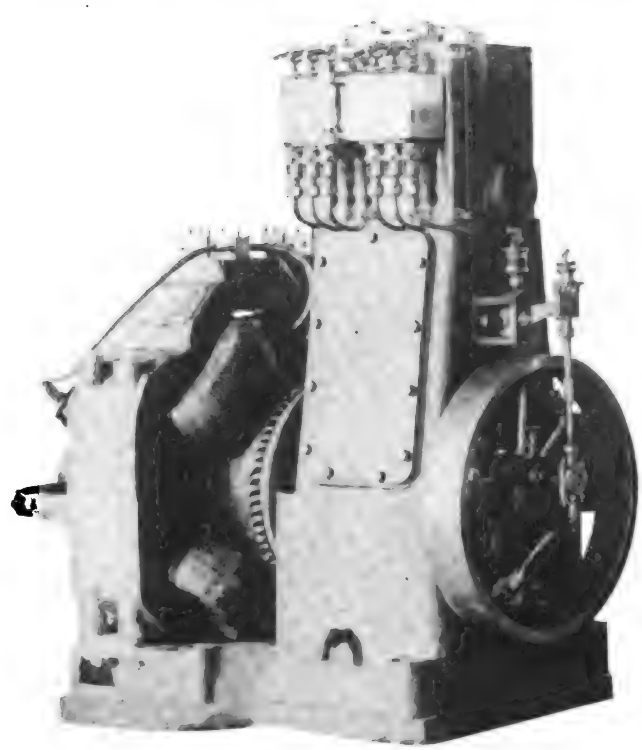
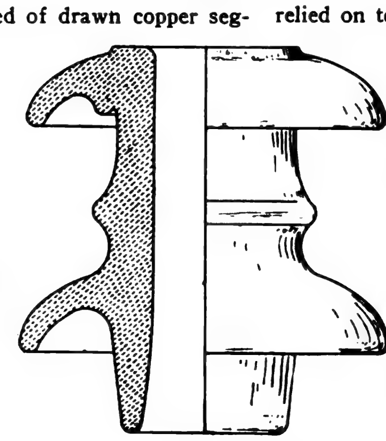


FIG. 8.—COMPACT GENERATING SET.

Y. The increase in the use of high-tension electric railways will naturally call for insulators capable of withstanding high mechanical as well as high electrical strains. The strain insulator shown by Fig. 9 is 6 ins. high and 5¾ ins. in diameter and has been designed for voltages as high as 8000. The company has also developed a smaller strain insulator for voltages of 5000 and under, which is useful in the construction of spans for trolley suspension. The company now has a complete line of strain insulators for voltages up to 35,000 and is developing a new design for voltages of 60,000 or more. With regard to the mechanical strength of the insulators, the company states that the larger designs can be relied on to withstand a breakdown test of



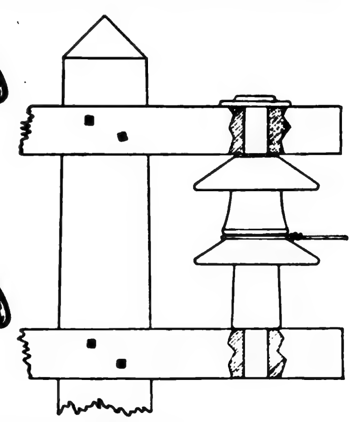


FIG. 9.—STRAIN INSULATORS.—FIG. 10.

approximately 12,000 lbs., with the insulator supported by a pin passing through the middle and the strain applied around the middle wire groove. In connection with

these insulators the company has also developed a method of using them whereby almost any strain up to several tons may be applied with safety.

SABLE RAWHIDE BELTING.

The Sable rawhide belting made by the Shultz Belting Company, of St. Louis, Mo., is made from selected rawhide said to be tanned so as to produce a surface very pliable and yet leaving underneath the long

FIG. 11.—SABLE RAWHIDE BELTING.

fibers that make it tough, unbroken and unseparated. The manufacturer claims that it will transmit a third more power than the best oak-tanned belt and last longer. Sable rawhide belting of double thickness, the maker claims, will turn around as small a pulley as oak-tanned leather belting of single thickness. Fig. 11 herewith gives an idea of the flexibility of the belting. This, the manufacturer maintains, is easily done with Sable belting of double thickness.

EXPERIMENTAL DYNAMOS.

Fig. 12 herewith shows the Midget dynamo, equipped with hand power made by the Elbridge Electrical Manufacturing Company, of Elbridge, N. Y. The dynamo has

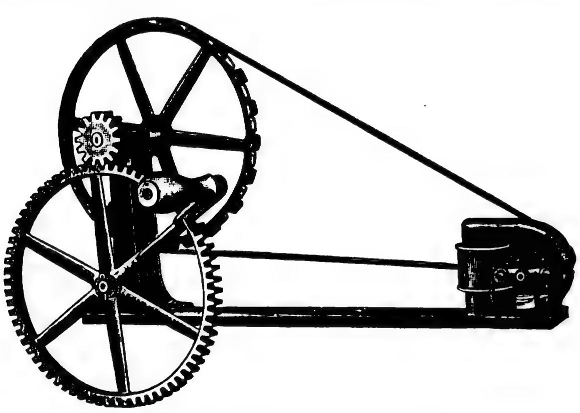


FIG. 12.—EXPERIMENTAL DYNAMO.

an output of 10 watts, and is wound for 4, 8 and 10 volts. The hand power device is suitably geared so as to give the required speed without too much exertion on the part of the operator. The entire outfit is mounted on a wooden base.

NEW BOOKS.

HOME MECHANICS FOR AMATEURS. By George M. Hopkins. New York: Munn & Co. Cloth. 370 pages, 5½ inches x 8 inches; 326 illustrations. Price, $1.50.

The compiler of this book, and author of many of its chapters, had a positive genius for the class of work represented by the book, and the contents are typical of his best efforts in this field. The book contains full illustrated instructions for making a large number of specific pieces of machinery and apparatus, together with three chapters on wood-working, metal-working and making household ornaments. It will be found of great interest by any intelligent amateur and of considerable value in some respects to the skilled amateur mechanic.

THE ELECTRICAL TRANSMISSION OF ENERGY. By A. V. Abbott. (Fourth Edition.) New York: D. Van Nostrand Company, 1904. Cloth. 675 + xxx pages, 6 inches x 9 inches; 367 illustrations; numerous tables and charts. Price, $5.

This edition of Mr. Abbott's well-known work shows evidence of most comprehensive revision, and has been brought thoroughly up-to-date excepting in a very few instances. Notable lapses in this respect occur on page 352, where resistances are given in obsolete "Legal" ohms and B. A. units only; on page 448 *et seq.*, where *J* is used to represent impedance, instead of *Z*; in table No. 72, where useless impedance factors for lines are given; on page 519, where obsolete three-wire balancing apparatus is described, and on page 576 *et seq.*, where dynamomotors are called motor-transformers.

Mr. Abbott also uses the symbol *L* for both C. G. S. units of inductance and henrys; his statement on page 619, immediately beneath the table, as to the relative voltages of single-phase and three-phase lines, is exactly the reverse of the fact, and his statements in many places are too loose for incorporation in a book of the generally high grade of this one. The book, however, stands out far and away ahead of anything thus far published along similar lines. It is extremely broad in scope, logical in treatment and mostly accurate and satisfying. The author's few inaccuracies are obviously due to too implicit a trust in statements of other writers and not to any lack of rudimentary knowledge of the subject; in all cases they occur where verification would involve tedious mathematical deductions, indicating that the enormity of the author's undertaking wore on his patience and induced a little carelessness.

QUICK DELIVERIES OF ELECTRICAL APPARATUS TO MEXICO.

In order to enable the Mexican Light & Power Company to effect prompt temporary repairs to its generating station in the City of Mexico, which was recently partially destroyed by fire, two express shipments were made by the General Electric Company from Schenectady recently, which were remarkable, both for their size and prompt despatch. Telegraphic advices were received by the Foreign Department on Monday, February 6, stating that a large quantity of switchboard material would be required to enable the plant to resume operation, although at the time the full extent of the damage was not known. As a result of further telegrams, and consultations by telephone with the New York representatives of the Mexican company, details of the order were settled Tuesday morning, and on Wednesday, February 8, the second day from the receipt of information of the trouble, an express shipment of thirty thousand pounds of switchboard instruments, switches and supplies left the Schenectady factory for Mexico City. The shipment constituted a complete switchboard equipment for a 4000-kw. power station, and to collect and despatch the material in this short time taxed every resource of the company. While most of the instruments and switches were available at Schenectady, it was necessary to obtain instrument transformers by express from Lynn, and four large rheostats for generators of German make had to be entirely built from data telegraphed from Mexico. In addition, a large quantity of wire and cable, which could not be supplied from the Schenectady stock, had to be borrowed from an installation which the General Electric Company was carrying out in New York City.

In handling the shipment from Schenectady, special arrangements were made with the railroad companies to obviate transhipments in passing from one system to another, and especially in crossing the Mexican frontier, and, in addition, a special messenger traveled with the car the entire distance to see that no delays occurred at junction points. The shipment reached Mexico City on Tuesday, February 14, thus placing in the hands of the customer, within seven days from receipt of the first news of the disaster and from a factory over 3700 miles away, a complete outfit of the new material necessary to restore the interrupted lighting and power service.

The fire also destroyed two engine-driven sets, making it imperative to install at once two 500-kw. Curtis turbine-generators that were on order at the time, and one of which was due to arrive by freight in a few days. The second turbine had just been loaded on a freight car at the Schenectady factory, but the urgent need of the machine decided the Mexican company to authorize its shipment by express. Of this shipment the turbine proper, as boxed, weighed 27,000 lbs. and occupied a space 8 ft. high by 8 ft. wide by 9½ ft. long. The doors of the ordinary express car would not admit the entrance of a "package" of these dimensions, but a special car having large doors was secured, and by stripping the boxing to a minimum the loading was effected. The generator and other parts brought the weight up to nearly 43,000 lbs., making one of the heaviest single express shipments ever made.

OBITUARY.

S. L. BARRIETT, president of the Barriett Electric Company, Cincinnati, O., died recently at his home in Cincinnati after a short illness. Mr. Barriett was one of the "old-timers" in the manufacture of small dynamos and motors, and for several years past—since the formation of his Cincinnati company—has also given his attention

to the design and manufacture of larger machines.

F. A. LA ROCHE, the well-known manufacturer of electrical apparatus, died at the Presbyterian Hospital last month of cancer of the stomach. He had been actively interested in the electrical industry since 1885, and was an inventor of considerable merit. During the pasts few years he became interested in the automobile industry, and made several remarkable runs in a car of his own manufacture.

C. C. WARREN, president and treasurer of the Warren Electric & Mfg. Company, Sandusky, Ohio, died on March 22, aged 70 years. Mr. Warren was one of the pioneers of the electrical industry, and prior to taking up manufacturing became prominent as a sales manager representing in the West at one time or another several of the important manufacturing companies. In closing out his electrical interest in the West as representative, Mr. Warren went to Sandusky, where he established the Warren Electric & Mfg. Company, of which he was the head until his death. Socially Mr. Warren was a man of most excellent qualities and was enthusiastic in promoting the welfare of his wide circle of friends and the community in general.

PERSONAL.

MR. W. H. WHITESIDE has been elected vice-president of the Allis-Chalmers Company, to succeed Mr. W. J. Chalmers, who recently resigned that position.

MR. WILLIAM KENT, Dean of the Syracuse University's College of Applied Science, is the author of a highly interesting paper on "The Engineer and His Education," which has been published in pamphlet form by the University.

MR. H. N. LATEY, of the engineering staff of the Interborough Rapid Transit Company, has been appointed Electrical Engineer of the company, his jurisdiction now covering both of the divisions of the system of the Interborough Company.

MR. C. H. NORWOOD has been appointed the Chicago representative of the Robbins & Myers Company, Springfield, O. Mr. Norwood's headquarters are at 1107 Fisher Building, where a stock of "Standard" dynamos and motors will be carried.

MR. E. A. SCHROEDER, who has been connected with the Crocker-Wheeler Company's St. Louis office for some time past, has been appointed manager of the company's New Orleans office, to succeed Mr. Field, who has been transferred to the Boston office.

MR. F. D. PHILLIPS, of Chicago, has been appointed general manager of the American Electrical Supply Company, of the same city. Mr. Phillips is an old Electrical Appliance man, and more recently was treasurer and sales manager of the Crescent Company.

MR. J. H. HALLBERG, the well-known arc-lighting specialist, has been engaged in a general advisory capacity by the New York commission on municipal lighting. The commission is evidently trying to make the best of a tough proposition by getting high-grade technical assistance.

MR. CHAS. D. KNIGHT has been appointed chief engineer of the American Electric & Controller Company, New York. Mr. Knight is widely experienced in the design and manufacture of electrical apparatus, having been on the staffs of the General Electric, Fort Wayne, National Electric and Cutler-Hammer Companies.

MR. ARTHUR WILLIAMS, of the New York Edison Company, has been appointed by President Ernest H. Davis, of the National Electric Light Association, to make a report at the Denver convention on "Municipal Ownership." It is needless to say that the report will undoubtedly be thorough and of extreme interest to central station men.

MR. CAMPBELL SCOTT, whose resignation of the general management of the C. & C. Electric Company was announced recently in this column, has been appointed director of the Yonkers works of the Otis Elevator Company. The company has our sincere congratulations on its acquisition of Mr. Scott's services; by natural ability and wide experience he is eminently qualified for the work.

MR. GARDINER C. SIMS, of Armington & Sims fame, has been appointed general manager of the Marine Engine & Machine Company. This company will take up the manufacture of the high-speed automatic engine designed by Mr. Sims and formerly built by the Armington & Sims Company. The design has been, of course, modified in details to correspond with the progress that has been made in the building of such machinery since the old company was actively in the field, but the fundamental characteristics will be retained. Entirely new patterns have been prepared.

MR. WALTER RAMSEY, who recently assumed the general management of the American Arc Lamp Company, successor to the Lea Electric Mfg. Company, Elwood, Ind., has practically revolutionized the company's business and raised the concern from a struggling position to one in which a splendid business is being enjoyed and the prospects for the future are most gratifying. Mr. Ramsey is a resident of Indianapolis, and has had an extensive business experience which he has applied to the affairs of the company—with the usual results. The company will probably move into its new factory at Kalamazoo, Mich., about the middle of May. Up to that time it will remain at Elwood.

TRADE PUBLICATIONS.

FLANGE JOINT GASKETS. H. W. Johns-Manville Company, New York.—A vest-pocket pamphlet devoted to "Kearsarge" flange joint gaskets.

CURTIS STEAM TURBINE. General Electric Company.—Publication No. 9137, of octavo size, containing illustrations of notable turbine installations.

CENTRIFUGAL PUMPS. De Laval Steam Turbine Company, Trenton, N. J.—A very complete publication containing a fully illustrated description of the De Laval centrifugal pumps.

STEAM BOILERS. The Brownell Company, Dayton, O.—An illustrated catalogue of standard size, devoted to the Brownell vertical and horizontal tubular boilers and sectional water-tube boilers.

MOTOR GENERATOR SETS. General Electric Company.—A handsome pamphlet of actavo size, containing illustrations and tabulated data of G. E. motor generators, together with views of some typical installations.

KAISLING PROTECTORS FOR TELEPHONE CIRCUITS. American Electric Fuse Company, Chicago.—A standard-size catalogue containing an illustrated description of self-soldering and self-restoring telephone-circuit protectors.

ENGINEERS' CHUMS. Mound Tool & Scraper Company, St. Louis, Mo.—This is the seventh edition of this little pamphlet, which is devoted to a description of the well-known Mound scraping tools, packing tools, cold chisels, etc.

ELECTRIC FAN MOTORS. Sprague Electric Company, New York.—Bulletin No. 309, consisting of a pocket-size pamphlet containing an illustrated list of the well-known Lundell and other fan motors made by the Sprague Company.

TRANSFORMER THRIFT. Moloney Electric Company, St. Louis, Mo.—A vest-pocket booklet, containing some forcible arguments as to the merits of Moloney transformers. The arguments are illustrated by some rather clever sketches.

TRANSFORMERS. The Crawfordsville Electric Company, Crawfordsville, Ind.—A handsomely executed catalogue of moderate size, containing a well-illustrated and detailed description of the Hornberger-Irwin transformers built by this company.

A MODERN INDUSTRIAL PLANT. Dodge & Day, Philadelphia.—Bulletin No. 175, in which the plant of an iron-working establishment at Hazleton, Pa., is illustrated as a typical example of the "modernizing" work of this progressive firm of engineers.

FAN MOTORS. General Electric Company.—The 1905 edition of this company's fan-motor catalogue, designated Publication No. 1048. The book is a beautiful specimen of trade literature; engravings, typography and presswork are all of the highest grade.

ECONOMIZING STEAM SPECIALTIES. The Williams Gauge Company, Pittsburg, Pa.—An illustrated catalogue of safety feed-water regulators, steam-operated traps, steam pump governors and safety water columns. The book is finely executed, especially as to the illustrations.

REYNOLDS-CORLISS ENGINES. Allis-Chalmers Company, Milwaukee, Wis.—Catalogue No. 120 of small-octavo size, containing illustrations of the varied line of Reynolds-Corliss steam engines. The book is executed in the ornate style characteristic of this company's literature.

AUTOMATIC STEAM PUMP AND RECEIVER. The Geo. F. Blake Mfg. Company, New York.—Bulletin B-81, containing an illustrated description of the Blake automatic pumping outfit for draining steam coils, jackets, etc., and returning the water of condensation to the boiler.

COMBINED BLOW TORCH AND SOLDERING IRON.—Emmelmann Bros. Mfg. Company, Indianapolis, Ind.—A vest-pocket pamphlet relating to an extremely ingenious soldering iron, the handle of which contains a blow torch that delivers its flame directly on the copper of the tool.

GAS AND OIL ENGINES. De La Vergne Machine Company, New York.—An ornate folder containing illustrations of the Koerting gas engines and Hornsby-Akroyd oil engines built by this company, together with a brief argument in favor of internal-combustion engines as compared with the steam engine.

MODERN HYDRO-ELECTRIC POWER STATIONS. J. W. Rickey, Minneapolis, Minn.—An octavo-size pamphlet containing illustrations and descriptive data of some notable plants in which the penstock construction advocated by Mr. Rickey has been employed by him. This construction is of concrete and steel.

TELEPHONE APPLIANCES. American Electric Fuse Company, Chicago.—This is a well-executed, pocket-size pamphlet containing illustrations of the comprehensive line of telephone-circuit protecting devices made by this company, excepting the American self-soldering protectors, which are described in a separate catalogue.

COMPRESSED FACTS ABOUT COMPRESSED AIR. Clayton Air Compressor Works, New York.—A finely executed booklet of vest-pocket size, designated Bulletin C-202, and containing a summary of the points to be considered in buying an air-compressor of medium capacity. The merits of the Clayton compressor are presented convincingly.

THE LIGHTING OF LARGE OFFICE BUILDINGS AND STORES. Holophane Glass Company, New York.—This is a companion to the beautiful little publications on illumination which were noted in this column a few months ago, and it is prepared in the same artistic style as the other two booklets. The character of the subject matter is indicated by the title.

BUSINESS NEWS.

THE BARRIETT ELECTRIC COMPANY, Cincinnati, O., announces that the death of its president will not cause any change in the policy of the company; its affairs will be continued as heretofore by the same general management.

CLAUDE T. LLOYD, Fremont, Mich., has purchased from the municipality its electrical supply department, and will carry in stock a full line of general supplies, as well as some attractive specialties, for the convenience of the trade in Western Michigan.

THE DODGE COAL STORAGE COMPANY, New York, has acquired the busines of the United Telpherage Company, of New York. Communications intended for the latter company should be addressed to the United Telpherage Department of the Dodge Coal Storage Company, 49 Dey Street.

THE MURRAY CORLISS ENGINE, which was exhibited at the St. Louis Exposition, is the subject of a page-long article and a two-page illustrative supplement in a recent number of *La Revue Industrielle, Paris*. The merits of the Murray Iron Works Company's product are evidently appreciated abroad, as well as in this country.

FRANCE PACKING COMPANY, Tacony, Pa., after a long series of experiments, has brought

out a metallic packing for gas engines which is sold under the same conditions as the well-known France packing for steam engines and pumps, namely, the coupon system, by means of which an engineer can gradually equip his plant with a full outfit of tools without cost to himself.

PARTRICK, CARTER & WILKINS, Philadelphia, have moved into their new factory, at 22d and Wood Sts., where practically twice the floor space will be available that was afforded by the old quarters. The demand for this firm's annunciators and other house goods shows the steady growth indicative of all product "sold on merit."

QUAKER CITY RUBBER COMPANY, Philadelphia, continues to receive flattering letters about its P. P. P. packing for piston rods, valve rods, etc. The chief engineer of the Polar Star Electric Company, Faribault, Minn., wrote some time ago as follows: "We ran one set of your P. P. P. packing on the main rod two years and 9 months, adding during this period one ring. I have used every known packing on the market, but never have been able to secure such service from any of them."

DOSSERT & COMPANY, New York, manufacturers of solderless electrical connectors, report that they have supplied L. T. Comstock & Co. with all the terminals for the panel-boards throughout the new Trinity Building, New York. The terminals, 380 in all, vary in size from No. 10 B. & S. gauge to 500,000 circular mils., cross-section. A number of Dossert connectors were recently shipped to Dr. Giorgio Finzi, Milan, Italy, for the equipment of the first large (400-h.p.) car for the Valtellina single-phase railroad.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., has received an order from the Northern Electrical Manufacturing Company, Madison, Wis., for 135 of the new type of C.-H. machine-tool motor controllers, equipped with fuses and switch in conformity to the U. S. Navy specifications. All of these controllers will be installed in the plant of the Winchester Repeating Arms Company. Although this controller has been on the market but a few months, its sales have far exceeded the most sanguine expectations of the company.

BARTZ, WYGANT & BROWN, Hornellsville, N. Y., have one of the most modern and thoroughly equipped shops in central New York. The machine shop and erecting department are on the first floor; the winding, painting and drafting departments and the offices are on the second floor, and the stock and shipping rooms in the basement. The machinery is all motor-driven, the motors being supplied by B. W. & B. generators, belt-driven by a gas engine. The company's dynamos and motors are steadily making friends throughout the trade.

THE STROMBERG CARLSON TELEPHONE MFG. COMPANY, Chicago and Rochester, reports that the Tri-State Telephone Company, Grand Forks, S. D., recently began giving commercial service from the exchange installed by the Stromberg-Carlson Company, and has an excellent list of subscribers right from the start. Contracts for switchboards have been closed with exchange companies at Fairpoint, O.; Illinois City, Ill.; Maple Lake, Minn.; Lathrop, Mo.; Granger, Tex.; Toledo, O.; Parnell, Ia.; Carmi, Ill.; and Philadelphia, Pa., as well as one with the Curtis Publishing Company, Philadelphia, for a central energy switchboard of the most modern type.

THE REEVES ENGINE COMPANY, Trenton, N. J., closed orders recently for a 16x16 horizontal engine for the Kansas City, Mo., City Hall; an 18x16 horizontal for the Sayville (L. I.) Electric Company; a 14x14 for the city lighting plant at Cedar Rapids, Iowa; a 6x7 vertical for the West Virginia Pulp & Paper Company, Tyrone, Pa.; two 12x12 horizontals for the Philadelphia works of George Hememant Company; a 10x9 vertical for Swift & Co., Brooklyn, N. Y.; two 12&20x16 vertical cross compounds for Ben Stanley Revett, of Denver, Col.; two 10x9 verticals for Farr-Alpaca Company; a 16&26x18 vertical cross compound for the City Hospital at Philadelphia, and numerous others.

PITTSBURG GAGE & SUPPLY COMPANY, Pittsburg, Pa., recently sold White Star continuous oiling systems to the Western Electric Company, Chicago; Chicago Consolidated Traction Company, Chicago; Northern Texas Traction Company, Handley, Tex.; Kremming Real Estate Company, St. Louis, Mo.; American Steel & Wire Company, Cleveland, O.; International Bank Building, New York, and Wyoming Shovel Company, Wyoming, Pa. A careful test conducted by the Massachusetts Mills in Georgia, Lindale, Ga., where a White Star oiling system was installed two years ago, is said to have developed the fact that the elimination of hand oiling by this system on an engine of 2000 horse-power has produced a saving of about 75 per cent. in the oil consumption.

THE PEERLESS ELECTRIC COMPANY, Warren, Ohio, reports the recent sale of a special laboratory generator to the Bliss Electrical School, Washington, D. C., and a number of motors to the Massachusetts Institute of Technology, Boston. An installation of thirteen press motors has just been furnished A. I. Root, Inc., Omaha, Neb.; an equipment of generator and twelve motors for the School News at Taylorville, Ill. Among orders just secured may be noted one for equipping the plant of the Oil City (Pa.) Derrick Publishing Company with a generator and eleven motors; eleven motors for the printing house of Nitschke Bros., Columbus, Ohio; S. Barker & Sons, printers and stationers, Cleveland, Ohio, six motors; and eleven linotype motors for the Manitoba Free Press, Winnipeg, Man.

MORE BIG CROCKER-WHEELER ALTERNATORS.—An order for four 4000-kw. three-phase, sixty cycle, 6600-volt alternating current generators, with exciters, has just been placed with the Crocker-Wheeler Company, Ampere, N. J., by the trustees of the Sanitary District of Chicago. These are to be driven by Wellman-Seaver-Morgan horizontal water-wheels and put in operation at Lockport, Ill., the western end of the Chicago Sanitary and Ship Canal. This is the second contract secured by the Crocker-Wheeler Company for large alternators. It will doubtless be recalled that the California Gas & Electric Corporation recently placed an order for three 4000 K.V.A. Crocker-Wheeler alternating current generators, to be driven by gas engines, which will supply current for all the street railways in San Francisco.

LAGONDA MFG. COMPANY, of Springefild, Ohio, manufacturer of the well-known Weinland tube cleaners and other steam and boiler-room specialties, now has branch offices in the following places: Pittsburg, Iron Exchange Building, Robert Gregory, manager; Philadelphia, Builders' Exchange, Jas. V. Davidson, manager; New York, 123 Liberty Street, C. A. Gillett, manager; St. Louis, 511 Missouri Trust Building, J. P. Maloy, manager. The company has the following selling representatives: Chicago, The Chicago Engineer Supply Company; San Francisco and Los Angeles, Chas. C. Moore & Co.; Toledo, O., Hardy & Dischinger Company; Kansas City, Mo., E. D. Hornbrook; Peoria, Ill., Kinsey & Mahler; Indianapolis, Ind., Hide, Leather & Belting Company; London, Eng., Selig, Sonnenthal & Co. This information is given for the convenience of the trade; anything needed in the Lagonda line can be furnished promptly from any of these points.

THE BALL & WOOD COMPANY, the well-known engine builders of Elizabeth, N. J., are adding a new department to their business, that of flange welding and pipe bending. The increasing use of high pressure and superheated steam has developed the need of pipe joints which are absolutely reliable, and in the process the company is bringing out the use of forged steel flanges welded to the pipe is designed to eliminate two out of the three weak spots in every steam joint, the pipe and flange being made homogeneous. Contracts have been let for a new smith's shop at the Ball & Wood works for the purpose of doing this work and it is expected shortly to be in full operation. Mr. O. M. Jones has resigned his position in the New York sales office of the National Tube Company and become the manager of the new department. For information regarding this work letters should be addressed to the company's welding department.

ALLIS-CHALMERS COMPANY, Milwaukee, is landing important orders at a rate calculated to paralyze the vocal cords of any calamity howler. Among recent contracts may be noted a complete 2000-kw. power-house equipment, both steam and electric, for the Toledo Interurban Construction Company; machinery for entirely remodeling the power-house equipment of the Mansfield (O.) Railway, Light & Power Company; a 4000-kw. electrical equipment for the new power plant of the Turners' Falls (Mass.) Company; a heavy duty, cross-compound Reynolds-Corliss engine for direct connection to a 1500-kw. generator in the plant of the Detroit United Railway, and a complete engine and generator unit of 500 kilowatts capacity for the Wells Building Company, Milwaukee. The company will be represented hereafter in Western Australia by Mr. F. R. Perrot, whose headquarters will be at Perth. In New Zealand, the firm of John Chambers & Son, Ltd., at Auckland, is now looking after Allis-Chalmers interests.

THE STANDARD UNDERGROUND CABLE COMPANY, Pittsburg, Pa., announces that on account of the general growth of its business on the Pacific Coast, it has been decided to discontinue all agency arrangements and to open a branch office in the Rialto Building, San Francisco. Mr. A. B. Saurman is manager for the Pacific Coast territory, which includes Washington, Oregon, Idaho, California, Nevada, Arizona, British Columbia, Alaska and the Hawaiian Islands. Mr. Saurman has been connected with the Standard Underground Cable Company in both the construction and sales departments at Philadelphia and New York, and was later for several years manager of the Boston office; for the past two years his position has been that of manager of the Pacific Coast Sales Department. The company expects to make announcements soon of the location and personnel of sub-offices at Los Angeles and Portland. The factory at Oakland, Cal., (the only factory west of the Mississippi equipped with lead presses for cable work) has been unusually busy during the past six months, and the prospects on the Pacific Coast point to continued activity.

WESTINGHOUSE ELECTRIC & MFG. COMPANY reports a continuance of "big business." The following recent contracts speak for themselves: As an extension to its system the Louisville Railway Company will install two 750-kw., three-phase rotary converters, six 300-kw., air-blast transformers with blower outfits, and two switchboards. The United Railways & Electric Company, of Baltimore, has contracted for three 1000-kw. rotaries and nine 350-kw. air-blast transformers. These will operate on a 13,000 volt line, transforming to 330 volts. Eighteen rotary converters with a total capacity of 27,000 kilowatts, in 1000 and 1500 kw. units, will be placed in sub-stations of the New York Central Railroad Company. Two 1500-kw., direct-current generators will be built for the Carnegie Steel Company to furnish power for two 1500-h.p., 230-volt motors. For the protection of this apparatus, 10,000-ampere circuit-breakers will be mounted on the switchboard. These motors, it is stated, will be the largest ever built for this voltage. The Westinghouse Company is also building for the Peoples Power Company, of Moline, Ill., two engine-type generators, to increase that company's present equipment. The machines will be a 1100-kw., two-phase alternator of the revolving field type, operating at 2400 and 4800 volts, and a 600-kw., 600-volt, direct-current machine. An order for three 300-kw. alternating-current generators has also been received by the Westinghouse Company from the Barber Lumber Company, of Boise, Idaho. These machines will generate current at 440 volts, which will be transformed to 23,000 volts for transmission. The necessary transformers, switchboards and lightning arresters are included in the apparatus to be furnished. The Mammoth Copper Mining Company, of Salt Lake City, has just placed an order with the Westinghouse Company for a large addition to their electrical equipment, comprising a total of nearly 800-horse-power in three-phase induction motors of different sizes, together with a motor-generator set, transformers, switchboard and three mining locomotives. Two of the motors have a rated capacity of 200 h.p. each, and five are of 50 h.p. each.

THE ABNER DOBLE COMPANY, San Francisco, reports a substantial and increasing business in tangential water wheels, particularly in large units, the percentage increase in horse-power of wheels sold by the company in 1904 over 1903 being 116 per cent. Among orders recently taken was one for three 7500-h.p. wheels for the Electra plant of the Standard Electric System. One of these will operate under a 1250-ft. head at 400 r.p.m. The other two wheels will be direct-connected to one 4000-kw. generator, forming a double unit for utilizing water from two separate sources under different heads. The design of this unit is an unusual one, in that each wheel has sufficient capacity to drive the generator at full load. One of the wheels will be driven by a 6-inch jet under a head of 1465 feet, the water being taken directly from the main gravity conduit; the other wheel is to be driven by a 7-inch jet under a head of 1250 feet, the source of supply being a large reservoir at the end of the main conduit. A 200-h.p. Doble exciter wheel to operate under a head of 1465 feet at 720 r.p.m. will also be furnished for the Electra plant. Two 800-h.p. main unit wheels and two 40-h.p. exciter wheels have been built for the new Santa Ana No. 2 plant of the Edison Electric Company of Los Angeles, to operate under a head of 305 feet. Two 75-h.p. exciter wheels have been built for the Pike's Peak Hydro-Electric Company of Colorado to operate at a speed of 975 r.p.m. under a head of 2100 feet, the highest in the United States. A 300-h.p. double Doble wheel equipped with two Doble needle regulating nozzles has been ordered by the Hilo Electric Light Company of Hawaii. For the Nevada City plant of the California Gas & Electric Corporation, three 570-h.p. wheels have been supplied to operate under a head of 190 feet. The Bredon Copper Company of Chile has ordered four 340-h.p. wheels for operation under 930 feet head, three for belt drive and one for direct connection to an electric generator.

CENTRAL STATION NEWS

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

ALABAMA.

WIGGINS.—The Wiggins Electric Light Company has filed articles of incorporation, with a capital stock of $10,000.

BREWTON.—A change is being made in the municipal electric lighting system, the open arc lights being displaced by series enclosed arc lights.

WEST END.—The City Council has granted the Birmingham Railway, Light & Power Company, of Birmingham, a franchise to lay gas mains and construct an electric light system in West End.

GREENVILLE.—The C. C. Henderson Electric Light Company has secured a franchise for an electric light plant. The cost of the plant is estimated at $15,000, and it is to be in operation within four months.

STURDEVANT.—The Tallapoosa Water Power & Electric Company, which was incorporated several months ago by Messrs. Aufeld & Chapman, of Montgomery, is about to begin the erection of a $500,000 plant for developing the water-power of the Tallapoosa River to furnish electric power for manufacturing purposes.

ARKANSAS.

MADILL.—W. F. Porter has been granted a 20-year franchise to establish and maintain an electric light plant here.

PARAGOULD.—The Crystal Ice Company, owner of the electric light plant here, purposes installing a new 250-hp. boiler in its power house.

FAYETTEVILLE.—New machinery has been added to the electric light plant at Fayetteville, which gives the plant a capacity of 5500 incandescent lights.

HARRISBURG.—Reports state that bids will be received until about Apirl 15 for the construction of an electric light plant for this town, the plant to cost about $4000.

TEXARKANA.—Improvements amounting to $50,000 in the electric lighting system are said to be contemplated by the Texarkana Gas & Electric Light Company, of this city.

PRAIRIE GROVE.—C. L. Cummings is said to be interested in establishing an electric light plant here. The project is being discussed, but no definite plans have as yet been formulated.

LITTLE ROCK.—New machinery, consisting of a 350-hp. boiler and a 350-hp. Corliss engine, has been installed recently in the municipal electric light plant. John W. Bleidt is superintendent of the plant.

GAINESVILLE.—C. W. Moore, of this city, and associates have incorporated the Gainesville Gas & Electric Company, with a capital stock of $100,000. The company will establish and operate a gas and electric light plant.

CALIFORNIA.

CEDARVILLE.—H. Hawkins is said to be interested in the construction of an electric light plant for this place.

OXNARD.—Local reports state that plans are being discussed for the establishing of a new electric light and power plant which will cost about $100,000.

MAYFIELD.—A company of local capitalists has been organized for the purpose of establishing an electric lighting plant to furnish light and power for the town and vicinity.

BODIE.—The Walker River Electric Company has been incorporated by Arthur Cohn, Charles Day, Will Reading and others. The capital stock of the company is stated to be $20,000.

SANTA MONICA.—The Citizens Gas & Electric Company has filed articles of incorporation with the Secretary of State, with a capital of $60,000. F. E. Bundy is president and C. C. Rathbone is also among the incorporators.

SAN FRANCISCO.—Articles of incorporation have been filed by J. A. Kretschmar and J. Alexander, of this city, and P. C. Medcraft and L. A. Redman, of Alameda, for the Oro Water, Light & Power Company, capitalized at $3,500,000.

BAKERSFIELD.—The Trustees are advertising for sealed proposals for furnishing all material and appliances and installing a complete electric fire-alarm system in that city, according to plans and specifications on file. A. T. Lightner is city clerk.

FAIR OAKS.—A meeting of the citizens of this town and Menlo Park was held recently at the latter place for the purpose of devising means to establish an electric lighting system. John McBain and John H. O'Keefe were appointed a committee to investigate the feasibility of the plan.

LAKEPORT.—It is reported that James K. Burch has applied for a franchise to erect poles and suspend wires on the highways, streets and alleys of this town for the purpose of transmitting light, power and heat. Bids for the franchise will be received April 3 by H. V. Keeling, Clerk.

SALINAS.—The new machinery for the Monterey County Gas & Electric Company's plant at this point is expected to arrive in the near future. The equipment will consist of two 250-h.p. boilers and two 200-h.p. Corliss engines; also two 150-kw. National alternators of the revolving-field type.

SAN FRANCISCO.—The Battle Creek Power Company has been incorporated, with a capital of $1,000,000, by Henry Ward Brown and Walter E. Carre, of Colma; Harold L. Wright, of this city, Dudley Bates and others. Plans are under way for the construction of a power plant at Gridley, this State.

OROVILLE.—E. W. Sutcliffe, representing the Northern California Electric Railway & Navigation Company, has been granted a two-year franchise for a pole line to transmit electricity over the streets and highways of Butte County. The purpose of this two-year franchise is to allow the company to construct its line immediately.

SAN FRANCISCO.—A party of Denver capitalists who are interested with Lawrence Phipps on the Bishop Creek project to supply Tonopah and Goldfield, Nev., with electric power, have been in San Francisco completing arrangements for the carrying out of the enterprise. Among the party were Rodney Curtis, of Denver; Samuel Woods and F. J. Campbell. The proposed plans of the company include the establishment of a generating plant at Bishop Creek in California. From the natural flow of the creek the company expects to develop 400 horse-power and will increase the capacity to 20,000 by the construction of three small dams along the stream at a cost of $100,000.

ELMHURST.—Work is being rushed on the 500-h.p. motor-generator for the new electric plant being installed here. It will be necessary to run a wire from the Southern Pacific tracks to the power house, as the line from the Amador County source is not yet completed. A switch-house must be erected also. The Standard Electric Company, it is said, will have control of the power and will sell it to the Oakland Traction Consolidated Company. The old plant will be shut down, but is to be held in readiness for emergencies. There will be also a connection made with the De Sabla power house, near Chico, belonging to the Bay Counties Company, which will furnish electricity if needed. Water-power will be used in each of the primary power houses to generate alternating current at 50,000 volts. This will be transmitted to the Elmhurst plant, where direct current is also generated for the cars on the Haywards line of the Oakland Traction Consolidated Company.

UKIAH.—The Eel River Power & Irrigation Company has been incorporated recently with a capital stock of $500,000. The directors are: F. D. Madison, of San Francisco; W. W. Van Arsdale, H. B. Muir, R. E. Donohue and W. P. Thomas. Work will be commenced on the plant immediately. It will be located in Potter Valley, where a tunnel one and one-half miles long will be dug through the mountain, where it will have a fall of 470 feet to the wheels that will run the electric generators. The water will be taken from Eel River about 20 miles from this city and will be used to irrigate Potter and Ukiah Valleys after it has been utilized for power purposes. The plant will have an initial capacity of 500 horse-power, but the tunnel and ditches will be large enough to carry sufficient water to operate a 2500-h.p. plant. The city of Ukiah is particularly interested in this enterprise, and overtures for the purchase of the power and light are in progress. At the last meeting of the Board of Trustees a motion was made and unanimously carried, on behalf of the city, to make the new company an offer to enter into a contract with the company to purchase for a term of fifteen years, at $4.00 per horse-power, electric current to be delivered at the switchboard; the city to take 250 horse-power at first, with the absolute privilege of increasing the amount of current whenever the city sees fit, the limit being 500 horse-power. The city is to have the exclusive sale of electricity for light and power within a radius of three miles square, with the court house as a center. This will give an area of one and one-half miles each way from the court house, excepting, however, the new company shall have the right to sell power to the water works for pumping water for municipal purposes, or do it themselves, if they so desire. The city also reserves the right to sell light and power to Vichy Springs and the asylum. The plant is expected to be completed and in operation on or before October, 1906.

COLORADO.

MONTROSE.—The Town Council has granted the Montrose Light & Power Company a ten-year franchise.

FLORENCE.—The Arkansas Valley Electric Company of this city has been granted a franchise by the City Council, granting it the privilege to erect poles and string wires within the town limits.

SILVERTON.—The city authorities have arranged to install at the municipal electric light plant another 110-kw. unit and a new switchboard and the system will be changed to three-phase. H. S. Sherman is manager.

DILLON.—W. H. Foster, who last fall purchased the old Ora Grande placer workings a half mile north of Dillon, has interested New York capital and will shortly begin the construction of a large electric power plant on the property. The ditch from which the water power will be obtained is nine miles long.

AGUILAR.—At a mass meeting held recently a stock company was formed by A. R. Lindsey, Morris Pitti, H. Pinamonti, Dr. A. B. Harbison, and others, for the purpose of installing an electric plant and lighting system at a cost of $10,000. This is the first step toward municipal ownership, the city having an option on the purchase of the plant at the end of five years.

BOULDER.—The Boulder Electric Light & Power Company has made application to the Council for a new franchise. The old one does not expire for some time, but the company desires additional privileges, among them the right to haul freight through the streets of the city, and therefore asks for a new franchise. It will be voted upon by the people at a regular election.

EMPIRE.—W. P. Clough, of Denver, president of the Clear Creek County Power & Irrigation Company, writes that it is proposed to construct a water-power plant for the generation of electricity for mining and irrigation purposes. The plant, it is estimated, will cost about $75,000 and the contracts will probably be let about May 1. H. R. Oliver, of Georgetown, Colo., is the engineer in charge of the work.

CONNECTICUT.

WALLINGFORD.—Arrangements are being made at the municipal electric plant for the development of about 200 kilowatts by water power in order to supply a day service. This will be in addition to the present steam plant. A. L. Pierce is manager.

TORRINGTON.—At the annual meeting of the Torrington Electric Light Company held recently the following officers were elected: President, George D. Workman; treasurer, Frank M. Travis; secretary, Frederick F. Fuessenich, who together with Henry J. Hendy, Gideon H. Welch, James A. Doughty and John Workman constitute the board of directors.

GLASTONBURY.—James S. Williams, president of the Glastonbury Power Company, writes that engineers are now at work on specifications for the work in connection with the construction of its new power house and dam. The work will probably cost in the neighborhood of $175,000. No contract has been let as yet. Lewis W. Ripley is secretary of the company.

STAFFORD SPRINGS.—Arrangements have been made for the continued operation of the Stafford Springs Electric Light & Gas Company, and the announced intention to close down the plant has been reconsidered. Mr. Warner, of Bridgeport, has been appointed receiver for the company with authority to continue the operation of the plant. A re-organization of the company will probably be effected.

EAST HADDAM.—Ransom & Hoadley, of Providence, R. I., are said to have bought the entire rights of the Salmon River Power Company, which is controlled by the Connecticut River Banking Company, of Hartford, and expects to enlarge the plant at Leedsville, spending about $300,000 in improvements. The Salmon River Power Company has furnished power for the East Haddam Electric Light Company at Leedsville.

DELAWARE.

SEAFORD.—At a recent election the citizens voted in favor of the town owning its own electric light plant.

GEORGETOWN.—The Council has granted to the Georgetown Electric Light Company a franchise and a contract to light the city. There will be 100 lights installed. The company consists of George W. Goodley, W. R. Goodley and W. J. Peal, of Wilmington. The company has already awarded the contracts, and the work of installing the plant will begin at once.

DISTRICT OF COLUMBIA.

WASHINGTON.—The last legislation necessary to secure the placing underground of all telegraph, telephone, electric lighting and other overhead wires in the District of Columbia was enacted by the last Congress and signed by the President, March 3. Commissioner McFarland, who has been especially active in his efforts to secure the removal of all poles and overhead wires ever since he became Commissioner, estimates that within five years the people of the District can reasonably expect that all overhead wires within the city limits will be taken down and placed underground.

FLORIDA.

ST. AUGUSTINE.—F. N. Holmes, it is said, contemplates the construction of an electric light plant here.

GEORGIA.

CEDARTOWN.—A new steam power plant is being installed by the Water & Light Department of the town.

VALDOSTA.—A. W. Vamedoe, City Clerk, writes that the Mayor and Council are investigating the cost of an electric light plant.

COVINGTON.—The City Council contemplates re-establishing the city electric light plant, which was recently destroyed by an explosion.

JESUP.—The manager of the Jesup Light & Ice Company states that the company expects to increase the city lights about one-third very shortly.

TIFTON.—The Tifton Ice & Power Company recently installed a new engine and dynamo in its power plant. S. M. Roberts is manager of the company.

WASHINGTON.—Thomas Ludlow, superintendent of the municipal lighting plant, states that it is proposed to install a 150-kw. alternating-current generator.

FORT VALLEY.—The citizens have voted affirmatively on the proposed issuance of $12,000 bonds to establish an electric light plant and improve the water works.

CARTERSVILLE.—A committee has been appointed by the City Council, with W. H. Milner as chairman, to investigate the question of constructing an electric light plant and sewerage system.

ALBANY.—The contract for the erection of the dam and power house of the Albany Power & Manufacturing Company has been awarded to B. H. Hardaway, of Columbus. The terms of the contract call for the completion of the dam and power house by the first of September. The work involves an expenditure of about $100,000. Construction will begin at once.

SAVANNAH.—Articles of incorporation have been granted to the Savannah Lighting Company. The incorporators are John J. Cummings, Lawrence McNeil, John H. Estill, Joseph D. Weed, Henry Blun, Samuel Meinhard, Willis A. Burney, Jr., John Flannery, Samuel B. Adams, Pleasant A. Stovall, J. H. H. Entelman, B. H. Levy, George W. Tiedeman and Leopold Adler. The company proposes to carry on a general electric lighting and power business, the power being supplied from the Savannah Lumber Company's plant, on whose property the electric plant will be erected. The capital stock of the company is $50,000, they having the privilege of increasing it to $500,000.

CANTON.—A. J. Warner, formerly of Ohio, but now of Gainesville, and his associates, have been granted a charter by the Cherokee superior court incorporating the Etowah Power Company, with a capital of $10,000, with the privilege to increase to $1,000,000. The company expects to build a dam 600 feet long and 30 feet high across the Etowah River, about four miles below Canton, which probably will be completed during the year. The company organized by the election of A. J. Warner, president; E. P. Kirby, vice-president; W. K. Slack, secretary and treasurer; P. P. DuPre, of Canton, general counsel; W. A. Carlisle, chief engineer, and F. P. Catchings, electrical engineer. Board of directors: A. J. Warner, W. A. Carlisle, W. F. Huntley, E. P. Kirby, all of Gainesville; C. M. Merrick, of Pennsylvania, and P. P. DuPre and F. P. Burtz, both of Canton. The company has already acquired some property along the Etowah River.

HAWAII.

HONOLULU.—The Kauai Electric Company has been incorporated by D. P. R. Isenberg, William A. Kinney, Francis M. Swanzy, and others. The company is capitalized at $300,000 and will supply power for various purposes.

IDAHO.

HAILEY.—The owners of the Hailey Electric Supply Company propose building another plant at once.

SHOSHONE FALLS.—The electrical equipment for its plant has been ordered by the Shoshone Falls Power Company.

COEUR D'ALENE.—The Spokane Traction Company, of Spokane, Wash., will erect a $700,000 power plant at this point. Jay P. Graves is president.

WALLACE.—The Wallace Light & Power Company, of which D. C. McKissick is superintendent, will probably install some new machinery in its plant this summer and will also put in a steam plant.

MOUNTAINHOME.—A site has been selected at Crane Falls on the Snake River for the establishment of the proposed power plant of the Mountainhome Light & Transit Company, of this city. The construction of an electric road between here and the Snake River Valley is among the projects of the company.

BOISE.—Work is progressing rapidly on the Oxbow Tunnel on the Payette River, where later a large power plant is to be installed. The cost of the tunnel when completed is estimated at $125,000, and the total cost of the plant when thoroughly equipped and prepared to supply electrical energy to Boise and other cities will be about $1,500,000. The machinery for the plant will be on the ground in August, it is said, although it will be some months later before the plant wil be ready for operation.

ILLINOIS.

LEBANON.—It is proposed to install at the city light plant a new dynamo, engine and smoke stack.

STONINGTON.—L. D. Hewitt is said to be interested in the construction of an electric light plant here.

VERMONT.—The city expects soon to purchase a new dynamo for the electric light plant. Mr. E. L. Durrell is manager of the plant.

MORRISONVILLE.—The Morrisonville Electric Company is installing a central station steam heating plant in connection with its lighting plant.

MOWEAQUA.—The Moweaqua Electric Company, of which W. N. McKee is manager, proposes installing a steam heating plant (exhaust).

CHARLESTON.—The Charleston Illuminating Company has filed articles of incorporation. George M. Sefton, Flavion Mason, and others, are among the incorporators.

PANA.—Eastern capitalists are said to have been negotiating for the purchase of the electric plant here, and it is probable that the deal will be closed shortly.

PAXTON.—The Paxton Electric Company states that it is replacing arc lights with multiple-glower Nernst lamps having 2, 3 and 4 glowers, and finds them most satisfactory.

CHICAGO.—The Calumet Lighting Company, formerly the Calumet Gas & Electric Company, has conveyed its property and plant to the North Shore Electric Company, it is said.

MORTON.—Beyer Brothers, owners of the electric light plant, write that they expect to increase their power circuit to 150 kilowatts, and will install a 200-h.p. engine for the purpose.

PERU.—A new 150-h.p. boiler is to be installed in the municipal electric light plant, and about 7000 feet of 750,000 c. m. of stranded bare copper cable will be put in this summer.

BLOOMINGTON.—The City Council has granted to C. A. Griffin, S. R. White and P. R. Longworth a franchise to manufacture and distribute steam and electricity for heating, lighting and power purposes.

LA GRANGE.—By a vote of five to one the Village Board decided to sell the village water-

works and lighting plant to the Chicago Edison Company. None of the details of the transaction have as yet been made public.

SOUTH ELGIN.—V. W. Panton, owner of the local electric light plant, states that they have water power running to waste, and that extensions will be made to the present plant in order to utilize a portion or all of this.

DECATUR.—The Consumers' Gas & Electric Company has been incorporated with a capital of $50,000 to manufacture light, heat and power. Among the incorporators are W. M. Bering, Charles S. Needham and James M. Gray.

EAST ST. LOUIS.—Mayor Cook has appointed C. B. Goedde, Jacob Gohn and L. Smith a committee to visit other cities to ascertain the cost of electric lighting and of municipal ownership of electric plants. W. J. Crocker is city engineer.

MORRIS.—The Fields Electric Light Company has in contemplation the following improvements: 5 miles of line, a 250-h.p. compound engine, a 200-kw. alternator, one condenser, a pump, day power circuit and all-night service. Mr. F. B. Handwerk is manager of the company.

KIRKWOOD.—Plans are being considered for rather extensive improvements to the plant of the Kirkwood Electric Company, of which J. F. White is manager. A steam heating and pumping plant for the city will be added and the electric lighting circuits will be extended to two neighboring towns.

ROCKFORD.—With the opening of spring the Rockford Edison Company contemplates a large number of extensions. Besides the purchase of additional machinery, two boilers of 500 horsepower each will be placed in position soon. It is estimated that the cost of the improvements will amount to about $15,000.

EDWARDSVILLE.—The McKinley Syndicate, controlling and operating the interurban lines of the Illinois Central Traction Company, the St. Louis and Springfield Electric Railway Company and the St. Louis & Northeastern Railway Company, has purchased the power plant of the Edwardsville Electric Light & Power Company.

KEWANEE.—At the annual meeting of the Kewanee Light & Power Company, Xenophon Caverno, James K. Blish and B. C. Parkinson were elected directors for the coming year. The directors chose officers as follows: President and general manager, Xenophon Caverno; vice-president, James K. Blish; secretary, B. C. Parkinson.

DANVILLE.—Press reports state that the Danville St. Railway & Light Company is preparing to expend $50,000 in improving its lighting system here. Mr. W. B. McKinley, who is president of the company, is also contemplating improving his plant at Decatur, the improvements to include the installation of new boilers and the laying of new gas mains.

TAYLORVILLE.—The Taylorville Gas Company has bought the stock of the Taylorville Electric Company and the corporate name of the new concern will be the Taylorville Gas & Electric Company, with a capital stock of $127,500. For the present, at least, J. N. C. Shumway, who has been the manager of the Taylorville Electric Company, will be manager for the new corporation.

MOLINE.—The Westinghouse Electric & Manufacturing Company has been awarded a contract by the People's Power Company for a 1100-kw. two-phase alternator, operating at 2400 and 4800 volts and a 600-kw. 600-volt direct-current machine. The power company has also placed a contract for a 24x50x48-in. horizontal compound Reynolds-Corliss engine with the Allis-Chalmers Company.

ELGIN.—The town has leased its electric plant to the Elgin, Aurora & Southern Traction Company, from which it will purchase current. It is said that the latter company is preparing to furnish lighting current to several of the towns along its line. Motor-generator sets, together with the necessary transformers and switching apparatus, are being installed in some of the substations.

ZION CITY.—The Zion Building & Manufacturing Association contemplates installing a 500-h.p. engine direct-connected to a 300-kw. alternating-current three-phase 60-cycle generator, a motor-generator set, one 100-kw. three-phase 60-cycle machine, a switchboard of eleven panels, two 250-h.p. boilers of the Cahall type, and a series alternating street lighting system. Burton C. Dennis is manager of the lighting plant.

FREEPORT.—A. P. Goddard, formerly president of the Freeport Railway, Light & Power Company and a member of the National Electric Light Association, died at his home in this city recently at the age of 72. He was born in Franklin County, N. Y., but his family removed to Freeport when he was two years old. Mr. Goddard was prominently identified with the development of the town, having served as alderman, mayor and member of the board of supervisors. He also served in the Civil War as first lieutenant in the Illinois Volunteer Infantry, and was brevetted a captain for honorable service.

INDIANA.

HOPE.—George S. Cook has secured a franchise for the establishment of an electric light plant at Hope.

JEFFERSONVILLE.—James H. Duffy is promoting a project to establish an incandescent electric light service in Jeffersonville.

JASPER.—The Jasper Electric Light Company is engaged in rebuilding some of the lines and has recently installed a new alternating-current dynamo.

OOLITIC.—The Town Board has decided to construct a water works and electric light plant at an estimated cost of $23,000. George C. Morgan, Chicago, is the engineer.

HAMMOND.—The South Shore Electric Company has ordered from the Allis-Chalmers Company one heavy-duty 24x48-in. engine for direct-connection to a 425-kw. alternating-current Bullock generator.

INDIANAPOLIS.—The F. H. Cheyne Electric Company, of this city, has filed articles of incorporation, with a capital stock of $20,000. Frederick H. Cheyne and Roland R. Ferry are among the incorporators.

WARSAW.—The Winona Electric Light & Water Company has purchased the water and electric light plant at this place. It is proposed to erect a standpipe 150 feet high and 18 feet in diameter and make improvements to the electric light plant.

RIDGEVILLE.—Articles of incorporation have been filed by Joseph, C. L. and Arthur Lay for the Ridgeville Electric Light & Power Company, having a capital stock of $10,000. The company will construct and operate a light, heat and water plant.

MUNCIE.—W. F. Warren, superintendent of the city electric light plant, writes that it is proposed to construct a new central lighting plant at once. Gas or oil engines and storage batteries will furnish the power, and it is estimated that the plant wil cost $120,000.

BREMEN.—The superintendent of the municipal electric light plant writes that it is proposed to install a 250-h.p. Harrisburg Fleming engine about the first of April. New fronts for the boilers will be provided and a new heater and boiler feed pump will be put in.

TERRE HAUTE.—An ordinance has passed the City Council appropriating $1200 with which to employ an engineer to prepare plans and specifications for the proposed municipal lighting plant. The McCulloch Company, of St. Louis, has been selected to procure data and draw up the plans.

LAFAYETTE.—Isham Randolph, engineer of the sanitary district of Chicago, in his report to the business men of Lafayette who are interested in the feasibility of building a dam across Wabash River for the generation of power, estimates the total cost of the dam, hydraulic and electrical equipment at $248,000.

BICKNELL.—The Bicknell Light & Power Company, with a capital of $10,000, has been incorporated, with the following board of directors: A. L. Brocksmith, B. P. Barnes, J. G. Welton, J. H. Welton and E. G. Barnes. The County Commissioners have granted the company a franchise to furnish light in Bicknell.

ODON.—The Odon Light & Power Company is preparing plans for the construction of a new power house which will be equipped with new engine, boilers and dynamos. The company is also arranging to install a water works system, which will be completed in about eighteen months. C. N. McNeely is manager of the company.

BRAZIL.—The Brazil Electric Company has secured a site upon which to erect its new power plant, and the power house is now in course of construction. When this is completed the company will be in position to supply commercial service to the entire city. The work of extending the city lines will begin some time during this month or the next. The new machinery and equipment has been nearly all purchased or is under contract.

NEW ALBANY.—The Louisville & Southern Indiana Traction Company recently installed in the power house of the United Gas & Electric Company, of this city, two 500-kw. three-phase steam turbine units operated at 4500 volts. One of them runs the arc lights at Jeffersonville, five miles distant, and the current from the other one is transformed by a booster and operates the street railway at Jeffersonville. Both three and four-wire distribution are used, the former for lighting and the latter for the street railway.

NOBLESVILLE.—George W. Heinzmann & Company have been awarded a ten-year contract for lighting the city. The company is required to furnish 80 arc lights at $70 a light per year, and ten cents per thousand watts will be charged for incandescent lights. The old electric light company, which now has the contract, and the Noblesville Hydraulic Company have been consolidated with the new concern. The large dam across White River, north of the city, which the Hydraulic Company began two years ago, but which was not completed on account of an injunction, will be completed. The old company's present steam plant will be remodeled and held in reserve in event of the water power not being available at all times. The two plants, when in operation, will represent an investment of $150,000.

INDIAN TERRITORY.

TULSA.—The People's Oil & Gas Company has been granted a franchise to wire the city for electricity and pipe it for natural gas.

FORT GIBSON.—D. W. Bolich is making surveys for a proposed $1,000,000 hydro-electric plant, to be built on the Grand River near this point.

MADILL.—F. W. Porter, of Whitehall, Wis., has been granted the franchise for which he applied recently to construct an electric light plant in Madill.

SOUTH McALESTER.—Articles of incorporation have been filed with the Secretary of State by the Choctaw Electric Company. The company is capitalized at $150,000, with A. E. Pierce as president, and will succeed the South McAlester Electric Light & Power Company. M. M. Lindley is secretary, and A. W. Thomas, treasurer.

IOWA.

ATLANTIC.—The city authorities anticipate changing the entire system from direct to alternating current.

SIBLEY.—The Sioux City Interstate Supply Company, it is said, contemplates installing a local electric light system.

MANSON.—William Folkers, superintendent of the Manson Electric Light Company, writes that the plant will require a new engine before very long.

NORTHWOOD.—L. F. Madson, owner of the electric light plant here, contemplates installing an engine, two generators and new switchboard apparatus.

THIBODAUX.—Reports state that a storage battery system is to be installed at the municipal lighting plant, for the purpose of supplying fans, motors, etc.

KNOXVILLE.—The Knoxville Electric Company is installing a heating plant and will add an alternating-current circuit for the supply of outlying districts.

MAQUOKETA.—M. S. Dunn, H. W. Kruse, and other, have filed articles of incorporation for the Maquoketa Light & Heat Company, with a capital stock of $25,000.

RED OAK.—The Red Oak Electric Company reports that it is about to install two new 150-h.p.

boilers and one 600-h.p. horizontal Camp engine direct-connected to a 500-kw generator.

INDIANOLA.—J. M. Harlan, president of the Public Water Power & Heating Vompany, writes that about $25,000 will be expended in improvements. The company will install Scaife filters and purchase new pumps.

CENTERVILLE.—Richard Slattery, representing the Mutual Electric Light Company, has petitioned for a franchise to operate an electric light plant. The question will be submitted to the people at the spring election.

VALLEY JUNCTION.—The Valley Junction electric light and water plant, which has been in the hands of eastern capitalists, has been sold to four local parties, who will incorporate under the laws of Iowa and form a stock company. The title will be transferred to John Fisher, A. H. Dyke, J. T. and Charles Ashworth.

CORNING.—C. K. Munns, proprietor of the Munns Electric Company, writes that the plant of the Corning Electric Company, which has been in his hands as receiver for the past year, was bought by him at trustees sale in December last and the name changed as above. He expects to overhaul the entire outside construction this spring.

DECORAH.—The Decorah Electric Light Company contemplates developing a water power and transmission line to operate this plant and one at Waukon, in all eighteen miles of line. There will be required, besides a dam, two 200 to 250-h.p. wheels, two 128-kw. 6600-volt three-phase 60-cycle generators, about 250 kilowatts in transformers, and the usual accessories for such an equipment. W. H. Burtis is president of the company.

KANSAS.

WICHITA.—The Citizens' Light, Heat & Power Company expects to erect a new plant.

WICHITA.—The United Electric Company has been incorporated in this city with a capital of $10,000.

WICHITA.—The Wichita Railroad & Light Company reports that it is installing another alternator in its power plant.

LEAVENWORTH.—Local capitalists have completed arrangements for the building of a $5000 electric light plant at Onaga.

JEWELL CITY.—A. G. Blankenship writes that bids will be received May 15 for constructing an electric light plant to cost $2000.

LEAVENWORTH.—The United Gas & Electric Company, of which M. E. Springer is manager, recently installed in its power plant two new 72x18 horizontal boilers.

HIAWATHA.—The superintendent of the city electric light plant writes that the entire circuit is being reconstructed and the old open arc lights replaced with enclosed arc lights.

WICHITA.—The Merchants' Heating & Lighting Company is making arrangements for the construction of an electric light and heating plant to cost about $300,000. W. H. Scott, Marquette Building, Chicago, is the engineer.

ANTHONY.—W. K. Palmer, 718 Dwight Building, Kansas City, Mo., has been engaged as engineer for the city in connection with the construction of a municipal electric light plant. Plans and specifications are now being prepared.

JUNCTION CITY.—Reports state that the Republican River Hydraulic Power Company is preparing to construct a dam across the river at this point, where it expects to develop about 1200 horse-power by means of turbine water wheels for the generation of electricity.

LAWRENCE.—A movement is on foot here for the consolidation of the gas and electric light plants of the city. About $200,000 will be expended immediately, according to the report. F. A. Sharpe is said to be the chief promoter of the enterprise. It is probable that the dam across the Kaw River will be utilized for power purposes if the reorganization is consummated.

KENTUCKY.

HICKMAN.—Reports are to the effect that the electric light plant here was recently destroyed by fire, but none of the particulars have been learned.

NICHOLASVILLE.—C. S. Evans, manager of the municipal electric lighting plant, states that an alternating-current generator has been recently purchased and installed in the plant.

MT. STERLING.—The Mt. Sterling Electric Light & Water Works Company recently purchased a deep well pump and a 6x4x6 duplex boiler pump. Its engine equipment has also been thoroughly overhauled.

HARTFORD.—Ike C. Adair has been elected president and J. D. Cooper, vice-president and general manager of the Kentucky Light & Power Company, recently formed to install an electric light plant at Hartford.

LOUISVILLE.—At the annual meeting of the Evansville Gas & Electric Company the following officers were elected: President, E. B. Lewis, of Chicago; vice-president, F. J. Reitz; secretary, W. B. McDonald; treasurer and auditor, James H. Foster.

LAWRENCEBURG.—Organization of the Lawrenceburg Electric Light Company has been completed by the election of officers as follows: President, J. M. Johnson; vice-president, E. W. Ripy; secretary, C. A. Leathers; treasurer, R. S. Collins. An electric light plant will be installed by the company at once at a cost of about $12,000.

CARLISLE.—A recent fire entirely destroyed the plant of the Citizens' Electric Light Company, entailing a loss of $10,000, upon which there was only $2000 insurance. The destruction of the plant leaves the city in darkness until temporary arrangements can be made to supply illumination. The plant will be restored at once. C. F. Holderman is superintendent.

LOUISIANA.

NATCHITOCHES.—J. R. Carroll, superintendent of the Natchitoches Electric Light & Water Works Company, reports that it is expected to install a new engine and dynamo shortly.

ABBEVILLE.—George W. Summers, secretary of Council, states that it is proposed to construct water works, electric light and sewerage systems, and the question of issuing $45,000 worth of bonds will be submitted to a vote of the people.

LAKE CHARLES.—The discussion in reference to the construction of a municipal electric light plant has culminated in completed plans and specifications for a plant to cost about $70,000. The matter is now in the hands of the City Attorney, who will probably get it in shape very shortly.

ALGIERS.—R. S. Stearns, general manager of the Algiers Water Works & Electric Light Company, makes the statement that it is proposed to extend the system to Gretna and furnish that town with light. It is also proposed to construct ten miles of electric railway between Algiers and Gretna, installing a complete three-phase system.

SHREVEPORT.—As previously announced, bids are invited for the electric lighting of the city for periods of five and ten years, the number of lights to be not less than 150 and subject to increase. Arc lights are to be not less than 2000 candle-power. Bids must specify the charge for arc lights and also for incandescent lights and specify the maximum charge to be made to private consumers of arc and incandescent lights. The arc lights for street lighting shall burn every night. All bids must be in the hands of the City Comptroller by 6 p. m., April 11.

MAINE.

AUGUSTA.—The recent incorporation is reported of the Home Light & Heat Company, with a capital of $300,000. M. H. Simmons is president, and E. F. Whittum, secretary.

BAR HARBOR.—Recent reports are to the effect that New York and Boston capitalists have purchased the stock of the Bar Harbor & Union River Water Power Company and will construct a dam 60 feet high on Union River near Ellsworth.

PORTLAND.—The Consolidated Electric Light Company of Maine proposes adding to its plant the following equipment: A 360-kw. three-phase alternating-current dynamo, three 320-kw. 110-volt direct-current dynamos, one 1000-h.p. heater, one 1500-h.p. condenser and the necessary piping. G. E. Raymond, of Portland, is secretary.

MARYLAND.

LUTHERVILLE.—This town is now lighted by electricity furnished by the Mount Washington Electric Light & Power Company.

SALISBURY.—The Salisbury Light, Heat & Power Company has just completed and moved into its new fireproof power station. A new boiler house is now to be erected and the lines will be thoroughly overhauled this spring. Ralph B. Rhodes is manager of the company.

BALTIMORE.—The Board of Awards is considering the bids received on the 8th of March for the street electric arc light contract. Superintendent of Lamps and Lighting Robert J. McCuen, is also in receipt of a proposition from a New York engineering company to install a municipal light plant and citing the cost of the plant and the cost per light after the plant has been established. The plant suggested would consist of a 2000-h.p. double-unit gas producer, capable of operating many thousands of lights. The producers may be operated by coal, coke, charcoal, wood or peat as fuel. In the engine-room would be three 600-kw. generators. The approximate cost of the plant is estimated at $325,000, including building, piping, foundations and all necessary machinery and electrical equipment. The cost of producing the light is also gone into thoroughly, it being estimated at less than $25 for 3000 arc lights per year of 4000 hours. In case none of the bids is low enough to be satisfactory to the board, the proposition of the New York company will be taken up and thoroughly discussed.

MASSACHUSETTS.

WESTON.—The Weston Electric Light Company is planning to duplicate its boiler equipment.

MELROSE.—At a meeting of the Aldermen an order was passed authorizing the Mayor to make a contract with the Malden Electric Company for lighting the city for one year from February 1 at a cost of $12,256.

WORCESTER.—Reports state that C. T. Sherer and George Crompton are interested in the construction of an electric plant to supply light and power for the buildings in the square bounded by Main, Front, Commercial and Mechanic Streets, this city.

MICHIGAN.

BOYNE CITY.—The Boyne City Electric Company will shortly operate its plant by water-power.

ALPENA.—Bids are being considered for the construction of water works and an electric light plant.

BAY CITY.—The Council has granted to West Bay City a franchise to do commercial lighting in this city.

HOPKINS STATION.—W. F. Nicoli is said to be interested in the construction of an electric light plant here.

EVERT.—The advisability of installing in the municipal lighting plant a storage battery system is under discussion.

ST. CLAIR.—This city contemplates installing new boilers and pumps at the electric light and water works. Walter Ash is chief electrician.

BLISSFIELD.—The equipment of the city electric light plant is to be increased by the addition of a feed-water heater and new transformers.

BIG RAPIDS.—The W. E. Donley Electric Light & Power Company thinks it may be necessary to replace its present equipment with larger machines.

SHELBY.—It is proposed to install at the municipal electric light plant new engines and an alternating-current generator. H. L. Andrus is superintendent.

SAULTE STE. MARIE.—It is reported that about $1,000,000 will be expended in the near future by the Michigan Lake Superior Power Company for improvements.

GRAND RAPIDS.—The usual annual extensions are being made to the municipal lighting circuits, the new circuits, amounting to about 35,000 feet, being placed underground.

CHEBOYGAN.—The Cheboygan Electric Light & Power Company has recently installed two 500-kw. 11,500-volt 60-cycle alternating-current generators operating at 200 r.p.m. and direct-connected to Leffel turbines.

HART.—It is expected that a complete change will be made in the street lighting system during the year. The Fort Wayne open arc lights are

now used, but will probably be displaced by enclosed arcs of the same kind.

DETROIT.—A bill authorizing the issue of $150,000 improvement bonds for the Detroit Municipal Lighting Commission has been approved by Mayor Codd and sent to Lansing to be taken in hand by the Wayne County delegation.

SPRINGWELLS.—The town has accepted the bond of John A. Russell for $3000. Mr. Russell has a franchise for commercial lighting within the township, under the conditions of which the plant must be in operation by September 1.

CHARLEVOIX.—Plans are under way to operate the city electric light plant by means of current generated by water power at Bellerin and transmitted from there, a distance of 28 miles. A day circuit with a capacity of 500 horse-power will be added this year.

MARSHALL.—The superintendent of the electric light and water works writes that they have taken out the direct-current arc lights and installed a complete Westinghouse alternating-current street lighting system, together with an alternating-current generator for supplying the same.

ZEELAND.—It is proposed to install at the village electric light plant, some time during the spring or summer, a 25-kw. 235-volt direct-connected unit which will take care of the small or light loads. An all-night service will be inaugurated also as soon as this set has been put in.

ALBION.—The city has just turned down a 30-year electric light franchise proposed by the Jackson-Battle Creek Traction Company. Fault is also found with the present service from the gas plant which is owned by Grand Rapids parties and operated under a 30-year franchise granted in 1895.

ROMEO.—The village authorities are arranging to install a 1500-light alternator and 45 alternating-current arc lamps in place of one 50-light arc machine and direct-current series lamps. It is possible that a 60-h.p. engine will be purchased to operate the present alternator and a 125-h.p. engine for the new 1500-light machine.

SAULT STE. MARIE.—According to recent reports the Edison Sault Electric Company is prepared to let contracts at once for the construction of a new power plant here. About 3000 horse-power will be developed at first and the capacity of the plant will be increased as fast as the demand warrants. During the coming summer the company expects to invest about $120,000 in the undertaking. Alexander Dow, of Detroit, is said to be at the head of the enterprise.

PONTIAC.—The Clinton River Power Company is to be organized as soon as a franchise can be secured from the city. The promoters now control six miles of the Clinton River and are in possession of the necessary funds to push the scheme as soon as a franchise is granted. The company will be incorporated for $100,000. Water wheels, alternating-current dynamos and other equipment will be required. Seeley & Son, of Amy, Mich., are interested in the project.

DOWAGIAC.—The question of making necessary changes and improvements to the city electric light plants will be submitted to the people at the annual spring election. These will include the rebuilding of the pole line and rewiring the system, which will require about twenty miles of No. 6 W. P. wire, a 75-kw. regulator at the station, a few alternating-current series arc lamps, 150 incandescent series lamps, shunts, new 35-ft. poles, etc. D. E. Connine is superintendent of the plant.

DETROIT.—The Detroit Commercial Electric Light Company has been organized and an application made for a franchise. The promoters agree to start work within sixty days after the granting of the franchise. The concern is capitalized at $1,000,000, and the following-named parties constitute the board of directors: W. E. Fenwick, James Kennedy, Morris M. Green, Charles F. Medbury, James Hanley and H. W. Wells. Options have been secured on river front property 9000 feet east of the present plant of the Solvay Process Company at Delray. The generators will be driven by gas engines supplied from the Solvay Company's plant.

MINNESOTA.

WACONIA.—The citizens have voted for a bond issue of $4500 for the erection of a lighting plant.

WHITE BEAR.—The White Bear Electric Company will construct an underground lighting system at Manitou Island, which is distant one mile.

AUSTIN.—An alternating-current generator, having a capacity of 500 kilowatts, has been recently installed in the Austin electric light plant.

FOLEY.—Daniel Stimler, of Minneapolis, is said to have petitioned the Village Council for a 20-year franchise for an electric light plant here.

ST. PAUL.—The Berggren Electric Company has been incorporated with a capital of $50,000. E. F. and Godfrey Berggren are the principal incorporators.

WADENA.—The superintendent of the water and light plant is reported to have recommended a heat distributing system in order to utilize the waste steam from the plant.

SOUTH STILLWATER.—Fire recently partially destroyed the local electric light plant at this place, entailing a loss of about $5000. The plant will be reconstructed at once.

MINNEAPOLIS.—The International Lighting Company has filed articles of incorporation with a capital of $2000. C. W. and George M. Furbar, of this city, are the incorporators.

ANOKA.—W. J. Annon has resigned his position as superintendent of the Anoka Water Works, Electric Light & Power Company to accept an appointment as postmaster of this city.

DAWSON.—Andrew Thompson, owner of the local electric light plant, states that he expects to increase the capacity of the plant 10 per cent. and will install a larger engine to meet the demand.

WARREN.—W. Haney, superintendent of the city lighting plant, reports that the matter of constructing a duplicate electric light plant has been placed in the hands of a committee who will engage an engineer and ask for bids.

THIEF RIVER FALLS.—It is proposed to install a new 100-kw. direct-current generator at the municipal electric light plant, and about 3500 feet of bare stranded cable, with a diameter of 500,000 cir. mils, will also be added.

BRECKENRIDGE.—Several improvements are under way at the municipal lighting plant, including a new building and the addition of a 400-h.p. boiler and a new pump for the water works, together with several line extensions.

LAKE CITY.—The Lake City Electric Light & Water Company is enlarging its power house in order to make room for a new 40-h.p. engine and a 30-kw. alternator. The system is being changed from direct to alternating current.

STILLWATER.—The City Council has granted to the Stillwater Gas & Electric Light Company a 10-year franchise to light the city. The company will install a new system of incandescent lights for the streets and will make various other improvements.

KEYSTONE.—The Keystone Lumber, Power & Development Company is the name of a concern recently organized for the purpose of utilizing the water power near here and furnishing electric light to the town. C. J. Patton is one of the promoters of the enterprise.

ST. CLOUD.—The Public Service Company has been reorganized with a capital of $500,000. It is proposed to dissolve the receivership of the street railway company and to incorporate it with the Public Service Company. About $230,000 will be expended in improvements to the electric light and street railway plants.

INTERNATIONAL FALLS.—Press reports state that the Koochiching Power Company, which is about to develop the water power of these falls, has awarded to the Alpena Portland Cement Company the contract for the cement to be used in the construction of the dam, paper and pulp mill. The contract is said to involve $100,000.

ST. PAUL.—The redraughted form of the ordinance permitting the Union Manufacturing Company to extend its electric lighting system in the western portion of St. Paul has been approved by the Board of Aldermen. The measure now provides for a bond of $25,000 and allows for other public service corporations to use the poles on the payment of a proportion of their cost.

GRACEVILLE.—It is proposed to increase the equipment of the municipal electric light plant this spring by the addition of a 125-kw. direct-current generator direct-connected to a tandem compound condensing Corliss engine with a speed of 90 r.p.m. The feeder lines will be reconstructed also, and thirty 5-ampere arc lights will be installed for street lighting. P. F. Daly is superintendent.

MISSISSIPPI.

NEW ALBANY.—Bids have been received for the construction of water works and an electric light plant.

PASS CHRISTIAN.—Bids for lighting the town with electricity are now being considered by the Town Council.

PORT GIBSON.—The city contemplates installing at the electric light plant a 125-h.p. return tubular boiler and stack.

HOUSTON.—At a recent election the citizens approved the proposed bond issue of $13,500 for establishing an electric light plant and water works.

GREENVILLE.—L. B. Bradley, receiver of the Greenville Light & Power Company, states that it is intended to install a complete re-equipment of the station.

MISSOURI.

COLUMBIA.—The city is installing a new plant and the machinery of the old one is for sale.

NEW FRANKLIN.—A local company has been granted a franchise to erect and maintain an electric light plant.

MEXICO.—At a special election, held for the purpose of deciding the question, a franchise for 20 years was granted to the Mexico Electric Light Company.

MOBERLY.—The Moberly Gas & Electric Company purposes reorganizing and rebuilding its plant this spring, it is said. J. Green is president of the company now.

HUNTSVILLE.—Extensive improvements are contemplated by the Huntsville Gas & Electric Light Company, which will make its plant practically as good as new.

ST. LOUIS.—The Adrian Light & Fuel Company has filed articles of incorporation, with a capital stock of $50,000. William McCabe and John Betz are among the incorporators.

LAMAR.—The Lamar Light & Water Company states that it will be in the market for another engine, boiler and alternator this spring. W. O. Settle is superintendent of the plant.

KANSAS CITY.—Articles of incorporation have been filed by the Holt Electric Company, in which the capital stock is placed at $20,000. The name of the company was subsequently changed to the Empire Electric Power & Supply Company.

MOBERLY.—This city and Huntsville will be connected by an electric line shortly. The Moberly & Missouri Electric Railway Company has been awarded the contract for lighting the city of Moberly, the building of the railway being included in the contract.

HANNIBAL.—The new electric light plant, which has been in course of construction recently, has been put in operation. The plant cost $100,000 and is thoroughly up-to-date in every respect. The street railway company has arranged to receive its motive power from the plant.

MACON.—By a detailed report submitted by the electric light and water works committee of the Council, it is shown that the municipal plants earned last year $867.76, the first time in the 15 years' existence of the utilities named that the balance has been on the right side of the ledger. The installation of meters and more systematic methods are said to have accomplished the reform and placed the city properties on a paying basis.

NEBRASKA.

HUMPHREY.—The Humphrey Electric Light & Telephone Company has increased its capital stock from $15,000 to $50,000.

OSCEOLA.—Clarence Miller, proprietor of the local electric light plant, states that he will build new lines this coming summer.

BLAIR.—The Blair Electric Light & Power Company proposes installing a new boiler and direct-current generator and establishing a day circuit.

TEKAMAH.—J. M. Crowell, City Clerk, writes that it was voted March 7 to issue $10,000 for the purchase of the present plant or the installation of a new one.

ALMA.—The city has voted for a bond issue of $20,000 for the construction of water works and an electric light plant. Bids for the work will be received April 15.

PONCA.—On the 4th of April the village will vote on the proposition of bonding the town to the amount of $6000 for the purpose of establishing a lighting system.

FREMONT.—The improvements which have been under way for some time at the Fremont light and water plant have been completed and the plant is now prepared to furnish a satisfactory day service.

CRETE.—The municipal authorities recently displaced the old alternator with a larger machine which is belt-connected to the engine. The old arc machine has been discarded and the street lighting is now done with alternating-current series enclosed arc lamps with a potential regulator.

PLATTSMOUTH.—At a meeting of the directors of the Nebraska Lighting Company the sum of $25,000 was appropriated for the purpose of entirely rebuilding the local gas plant. Plans were also considered for making extensive improvements to the electric light plant. The improvement work will begin as soon as the frost goes out of the ground.

NEVADA.

WELLS.—The Elks Electric Light & Power Company has been incorporated with a capital of $100,000, by A. W. Hesson, John J. Hylton, C. J. Hood, and others.

RENO.—Dr. W. H. Patterson, president of the Reno Power, Light & Water Company, recently disposed of his interest in the corporation and has tendered his resignation as president. He will be succeeded in that office by P. L. Flanigan.

RENO.—The Nevada Power Mining & Milling Company is to install two 750-kw. three-phase generating outfits in its power plant, where current will be generated for transmission at 30,000 volts to the Tonapah gold field and surrounding mining districts in Nevada. The transmission line will be about 100 miles long.

NEW HAMPSHIRE.

MONROE.—The Monroe Water Power Company has been incorporated for the purpose of constructing dams across the Connecticut River and furnishing electricity in this state and Vermont. A. S. Batchellor, of Littleton; Charles H. Hosford, of this city, and George Van Dyke, of Boston, Mass., are among the incorporators.

NEW JERSEY.

VINELAND.—A new boiler is to be added to the equipment of the Boro electric light plant.

BERNARDSVILLE.—The Bernards Water & Light Company expects to add a day circuit to its service after May 1.

PASSAIC.—The City Council has under consideration the establishment of a municipal lighting plant and will probably petition the Legislature for permission.

MADISON.—Articles of incorporation have been filed by the Western Water & Electric Company, having a capital stock of $100,000. Charles E. W. Smith, George M. Ward and John H. Gindrat are among the incorporators.

HACKENSACK.—As a result of the meeting of the directors of the Gas & Electric Company of Bergen County, and a session of the stockholders of the concern, the plan to lease the plant to the Public Service Corporation for 999 years was ratified.

PATERSON.—The Beaver Lake Company has been incorporated to build and operate water works, supply electric power, etc. It is capitalized at $50,000 and the incorporators are Wayne Dumont, John A. Kane, Frank Wilson, of Paterson, and Denton W. Clark, of Green Pond.

NEW MEXICO.

CARLSBAD.—Up to October of last year the Public Utilities Company leased power from a private dam which was washed away at that time. The company is now building a dam of its own, six miles southeast of this city on the Pecos River, at a cost of $8000. A 35-inch Samson turbine operating under a 12-foot head, will be installed for the present, and another will be added later. New leads are being run and the entire system is being thoroughly overhauled and put in first-class condition.

NEW YORK.

ONEIDA.—The Madison County Gas & Electric Company has secured the city lighting contract for $6965.

HOOSICK FALLS.—W. Stanley Bruen has been appointed manager of the Hoosick Falls Electric Company's plant.

WATKINS.—The Village Trustees are said to have selected an engineer to prepare plans for an electric light plant.

COHOCTON.—The question of constructing an electric light plant here is under discussion by the citizens and Council.

ILION.—Governor Higgins has signed the bill authorizing this town to issue $25,000 bonds for establishing an electric light plant.

WARRENSBURG.—John G. Smith, proprietor of the local electric light plant, contemplates installing a new turbine in the power house.

ALBANY.—The Albany Electric Illuminating Company has reduced the price of lighting current from 20 cents to 15 cents per kilowatt-hour.

CASTILE.—The superintendent of the municipal electric light plant writes that new lines for commercial lighting will be erected in the spring.

RHINEBECK.—The Dutchess Light, Heat & Power Company, in order to provide for its growing business, has purchased a 200-h.p. water-tube boiler.

JAMESTOWN.—It is proposed to install at the city electric light plant a new 200-kw. turbo-generator outfit, and 50 street lights will be added to the service.

NEW YORK CITY.—The Board of Aldermen on March 7 approved the resoluton of the Board of Estimate authorizing a bond issue of $600,000 for a municipal lighting plant.

SODUS.—The electric lighting franchise which was granted to some local parties about one year ago by the town board has been transferred to other business men of the place.

LANCASTER.—The Depew & Lancaster Light, Power & Conduit Company expects to be able to furnish both arc and incandescent lighting service to the village of Sloan by the 15th of May.

WATKINS.—The Watkins Consolidated Gas & Electric Light Company has been placed in the hands of a receiver. Senator Cassidy, of Montour Falls, has been appointed to act in that capacity.

JAMESVILLE.—The Thomas Millen Cement Company is reported to have in contemplation the construction of an electric plant, to be used for furnishing light and power for all the surrounding villages.

NIAGARA FALLS.—At a meeting of the Council a franchise was granted to the Niagara Falls Hydraulic Power & Manufacturing Company to build conduits in the city streets and lay cables for the distribution of electricity for heat, light and power purposes.

BROOKLYN.—The Mayor has approved the ordinance providing for an issue of corporate stock to the amount of $100,000 in order to provide additional means for placing all electrical conductors underground in the Borough under jurisdiction of the Fire Department.

EAST CREEK.—The East Creek Electric Light, Heat & Power Company, of which J. D. Cairns, of St. Johnsville, is manager, has in contemplation the establishment of another water power plant 3½ miles above its present plant. A three-phase transmission line, operating at 15,000 volts, will also be constructed.

NEW YORK CITY.—Plans for the city electric light plant for the Williamsburg Bridge have been filed. It will be the city's first venture in municipal ownership of light plants. The plant will be built in Tompkins Street, south of Delancey Slip, adjoining the new incineration plant, and will cost about $20,000.

PITTSFORD.—The Pittsford Light & Heat Company has been incorporated by Samuel Hutchinson, John Steve and B. N. Wiltsie. The company was organized with a capital of $10,000 for the purpose of lighting the streets and public and private buildings in the town of Pittsford. Its charter is for fifty years.

ONEIDA.—The Oneida Board of Public Works has ordered the Madison County Gas & Electric Company to remove its high-tension wires running through Madison Street to furnish power for the village of Canastota. Hereafter the Board of Public Works will oversee the erection of wires to carry high-tension current in this city.

TROY.—A petition for a renewal of the charter of the Hoosac Electric Power Company has been presented to the Legislature by W. S. Kelly, of North Adams, Mass. The charter was granted some time ago, but was dissolved shortly after. An immense power plant at Howe's pond has been planned by the company to supply water to Adams, North Adams and surrounding places.

MORAVIA.—The Moravia Electric Company states that it has in course of construction an entire new plant, in which will be installed a 200-h.p. McCormick turbine direct-connected to a 120-kw. 125-cycle General Electric generator. A new dam is being built and the depth increased from 8 feet to 12 feet. At some future date the company hopes to rebuild its transmission line.

LITTLE FALLS.—T. N. Lovenheim, owner of the Consumers' Electric Light Company, has sold a half interest in his plant to William La Due. Mr. Loveheim announces that the capacity of the plant will be doubled, a new dynamo having been ordered, which will increase the service by 1500 lamps. The company is also rebuilding the structure which was recently burned.

CANASTOTA.—The Electric Light Commission in its report on the construction of a municipal electric light plant, estimates the cost of such a plant with a capacity of 50 arc lights and 6000 incandescent lights at from $30,000 to $35,000. It is said that the question of bonding the village for $35,000 for the purpose of establishing a plant will be submitted to the taxpayers at the coming election.

NIAGARA FALLS.—The Niagara Falls Electrical Transmission Company is the name of a concern recently incorporated to do a natural gas and electricity business in Western New York. The company is capitalized at $100,000 and is chartered for 50 years. The directors are Harry Highland and Frank Dudley, of Niagara Falls, and Frederick Nicholls, E. R. Wood and R. E. Thompson, of Toronto.

BUFFALO.—City Engineer Morse submitted his estimate of the cost of a municipal lighting plant recently to the Board of Aldermen. He figures that it would cost $1,792,000 to build such a plant and that with the plant in operation the lights would cost the city $72.20 each per year as against the present cost of $75. The Board of Aldermen, however, by a vote of 16 to 5 approved the action of its committee on laws and legislation in holding up the municipal lighting plant bill, and it is said that it will be impossible to secure any legislation on the subject this year.

STAPLETON, S. I.—Mr. Calvin Detrick, president of the Staten Island Light, Heat & Power Company, died February 18. Mr. Detrick was an early promoter of electrical enterprises and erected the first electric lighting plant in the Borough of Richmond. He also constructed the system of hot water supply for that Borough and was the builder of the first underground electric light supply system in Philadelphia, Pa. He was born in Monroe County, Pa., May 4, 1838, and although his office was in this city his home was in Brooklyn at the time of his death.

BROOKLYN.—The Brooklyn Edison Electric Illuminating Company says that by the reduction

in the retail rates for electric lighting, which became operative on January 1 last, an electric sign with 24 incandescent lamps may be illuminated for as low as five cents an hour. The use of electric signs by progressive merchants in all parts of Brooklyn has increased very rapidly during the last two years. The Brooklyn Edison Company will supply an electric sign, designed and lettered to suit any business, and install it free of charge, including the wiring. The company retains title to the sign.

GREENPORT, L. I.—Municipal ownership of light and water plants has passed the experimental stage here and is pronounced a success. The annual report of the village trustees, who serve as light and water commissioners, as presented to the taxpayers recently, shows for the operating account of the light department total receipts of $10,595.02. The cost of operating was $6,028.40, including fuel, salaries, improvements, extension of lines, bonds maturing and interest on bonds outstanding. There remained on March 1 $823.39 in cash and 20 tons of coal valued at $85. The sum due for lights furnished in February is $266.05. The cash receipts from sale of light were $8,865.14. In addition the village has the benefit of about 150 street lights which are maintained without any assessment on the property whatever. That is, the plant earns in addition to the above figures, a sum sufficient to pay for 150 street lights at a rate of $18 each per annum, or $1,700, which the village would be obliged to pay were the plant owned by a private corporation. During the past year the plant has been very materially improved and is giving even better service than ever.

NORTH CAROLINA.

DUNN.—The direct-current lighting system of the city is to be changed to alternating current for commercial use.

TARBORO.—It is proposed to install at the municipal electric light plant a new 150-h.p. boiler. C. A. Johnson is manager.

DALLAS.—Dr. S. A. Wilkins, Clerk of the Town Board, writes that it proposed to construct an electric light plant at a cost of $3000.

FAYETTEVILLE.—A new boiler, engine and alternating-current dynamo are to be installed in the municipal electric light and power plant.

ASHEVILLE.—B. M. Lee, City Engineer, writes that the Legislature has granted this city permission to borrow money for an electric light plant, but it has not yet been decided whether to do the work or not.

SALISBURY.—The Salisbury & Spencer Railway Company is reported to have sold an interest in its system to the American Gas & Electric Company, of Providence, R. I., and it is stated that the line now under construction between Salisbury and Spencer will be completed and put into operation, and an electric light system will be installed at Spencer.

NORTH DAKOTA.

GRANVILLE.—The Telephone & Electric Light Company, of this city, has decided to incorporate with $10,000 capital.

GRAND FORKS.—The Council is reported to be considering the installation of a municipal plant for commercial lighting.

WALHALLA.—John F. Mayers, proprietor of the local lighting plant, states that they may add another dynamo and will probably increase the lines, as they expect to add between 200 and 300 incandescent lamps to their circuits.

OHIO.

SYCAMORE.—A new 60-kw. alternator is being installed in the village electric light plant.

CLEVELAND.—The capital stock of the Brilliant Electric Company has been increased from $75,000 to $125,000.

COLUMBUS.—The Washington Gas & Electric Company has increased its capital stock from $100,000 to $150,000.

MARTINS FERRY.—A new 500-h.p. Hamilton-Corliss engine is being installed in the municipal electric lighting plant.

ARCANUM.—The citizens are reported to have voted on March 7 to issue $38,000 bonds for water works and an electric light plant.

JAMESTOWN.—The Jamestown Electric Light Company has recently installed a new alternating current incandescent light dynamo.

DILLONVALE.—D. L. Renneker has sold his interest in the Dillonvale Electric Light Company to W. L. Cole, of this city.

CADIZ.—The Cadiz Electric Company has been incorporated with a capital of $12,000. J. V. Conner is the principal party interested.

BOWLING GREEN.—The Lake Erie, Bowling Green & Napoleon Railway Company is making extensions to its central hot water mains.

NEWARK.—Bids are now being considered for furnishing for a period of ten years a system of electric or gas lamps for street lighting

PORTAGE.—The Forde Lighting Company, of this city, has increased its capital stock from $25,000 to $50,000. W. W. Green is the president.

BELLEFONTAINE.—The city expects to rebuild, during the coming summer, its entire municipal lighting plant, for which $50,000 bonds will be issued.

CARROLLTON. — The Carrollton Electric Company will add a new engine, dynamo and boiler in the spring. E. L. Swann is manager of the plant.

COLUMBUS.—The Public Service Company has received the contract for lighting the state house for the ensuing year, on a bid of three cents per kilowatt.

LOVELAND.—The City Council is said to have granted to H. C. Hubbell, of Toledo, a franchise to construct water works and an electric light plant at Loveland.

HOLGATE.—Extensions to the electric and pipe lines in connection with the municipal electric light plant and water works, will be made this spring, involving an expenditure of $2000.

CINCINNATI.—Henry W. Sage has resigned as secretary of the Cincinnati Gas & Electric Company. He is 65 years of age and has been with the company since 1870, becoming secretary in 1882.

CLEVELAND.—The Gillen Electric Company has filed articles of incorporation, with a capital stock of $10,000. The incorporators are S. H. Gillen, D. F. Streb, W. S. Rowell and A. L. Vermilye.

WOODSFIELD.—It is possible that the 125-horse-power McEwen engine and the 150-h.p. tubular boiler, now in use in the municipal electric light plant, will be sold and replaced with a 125-h.p. gas engine.

RIDGEVILLE.—The Ridgeville Electric Light, Heat, Power & Water Company has filed articles of incorporation, with a capital stock of $5000. Joseph, Samuel C. and Arthur J. Lay are the incorporators.

SPRINGFIELD.—An ordinance has been introduced at Springfield to give the Home Heating, Light & Power Company a blanket franchise throughout the city. The company will compete for the street lighting.

CINCINNATI.—H. C. Hutchinson, for some years connected with the Cincinnati Gas & Electric Company, has accepted a position as eastern representative of the Philip Carey Manufacturing Company, with headquarters at Buffalo.

URBANA.—A new company, headed by C. H. Marvin and T. A. Edmondson, now holds a franchise for an electric lighting and hot-water heating plant in Urbana. Steps will be taken at once for the erection of a modern plant.

NILES.—The city light and water works contemplate changing the street lighting system from direct-current open-arc lights to alternating-current enclosed-arc lights; also the installation of either a 300-kw. turbine or direct-connected engine and generator and a new feed-water heater.

BERKELEY SPRINGS.—The Berkeley Springs Light & Water Company has filed articles of incorporation for the purpose of operating water works and electric light plants. The company's capital is stated as $25,000. Recent reports are to the effect that it is proposed to bond the city for $500,000, the proceeds to be used for the construction of water works, an electric light plant and a city hall.

READING.—The Council is preparing to hold an election to vote on issuing $25,000 bonds for improvements to the Reading electric light plant, as follows: Two 300-h.p. tubular boilers set up complete on iron girders with stacks; one 250-h.p. engine; one 200-kw. alternating-current dynamo, with pulley, switchboard, etc.; one 100-light tub transformer; 75 enclosed-arc lamps, 6.6-ampere series alternating; 200 35-feet 5 and 6-in. poles, wire, mast, arms, etc.

COLUMBUS.—It is said that the Columbus Railway & Light Company is negotiating for a lease on the property of the Columbus Gas Light & Heating Company, now that John G. Deshler has retired as the head of the latter, and that the trade will shortly be closed. It is further said that the railway and light company is after a lease on the property of the Public Service Company, but officials of the latter deny this. The older company is making an endeavor to secure all the public service plants in the city if possible.

OKLAHOMA TERRITORY

ALTUS.—The Altus Light, Power & Ice Company has filed its articles of incorporation, with a capital stock of $25,000. The incorporators are A. Rennell, of St. Louis; Henry Braun, of Guthrie, and others.

OREGON.

DALLAS.—The Dallas Electric Light Company, of which J. G. Van Orsdal is manager, will install shortly a 200-h.p. engine, a 125-h.p. boiler, and will make some line extensions.

ONTARIO.—Seymour H. Bell and Charles H. Chance, of Sumpter, have been granted a franchise for constructing and operating an electric light plant in this city, the plant to be in operation within eight months. The outlay involved will be about $25,000.

BAKER CITY.—The Baker Gas & Electric Company is reported to have been sold to an Eastern syndicate, represented by Isaac W. Anderson, of Spokane. It is stated that about $400,000 will be expended in improvements, enlarging the capacity of the plant, and in constructing a suburban railway to Haines and the Lower Powder River Valley.

PENNSYLVANIA.

DANVILLE.—The municipal lighting plant is now in operation and is giving satisfaction.

BEAVER.—A franchise has been granted to the Valley Electric Company, to furnish the city with light.

WERNERSVILLE.—Bids are being considered for the construction of an electric light plant to cost $3500.

KUTZTOWN.—The citizens have voted to issue $15,000 bonds for the construction of an electric light plant.

LANSDALE.—The citizens have voted to issue $25,000, part of which will be expended on improvements to the electric light plant.

FAIRCHANCE.—The Borough Council has granted a franchise to the West Penn Lighting Company to extend its lines over all the streets of the borough.

BROWNSVILLE.—The Brownsville Light, Heat & Power Company, of which J. M. Bell is manager, proposes installing a 250-h.p. engine and a 200-kw. generator.

MT. UNION.—The Mt. Union Silica Brick Company has been granted a franchise for the construction of an electric light plant to light the brick works and also to furnish light to the town.

WILLIAMSPORT.—The Citizens' Electric Company contemplates installing a 150-kw. water power plant and a 300-kw. fuel oil plant, as soon as the weather permits. J. Fisher is manager of the company.

CONNERSVILLE.—George B. Markle, of Hazleton, has purchased the General Gas, Electric Light & Power Company's plant at this place. Mr. Markle announces that he will spend a large sum of money in improvements and extensions.

LINFIELD.—The Linfield Electric Light Company has been incorporated, with a capital of $5000, by Horace Ashenfelter, Royersford; William S. Emlig, Philadelphia; G. E. Brownback, Linfield, and A. H. Fry, Jr., Philadelphia. The company will furnish electric light, heat and power.

TURTLE CREEK.—The Rose Hill Electric Light & Power Company, having a capital of $20,000, has been organized to establish a power plant for furnishing Turtle Creek and adjacent boroughs with light and power. William L. Ledger is president and C. R. Trevaskis, secretary.

DUNMORE.—The Dunmore Light, Heat & Power Company has organized by electing the following officers and directors: President, A. L. Snowden; secretary and treasurer, E. M. Stack; G. M. Hallstead, F. B. Bull, H. H. Knapp, M. J. Murray, R. D. Manley, John Carney and M. B. Freedman

SCRANTON.—The Scranton Illuminating, Light, Heat & Power Company has organized by the election of the following officers and directors: President, A. L. Snowden; vice-president, G. M. Hallstead; secretary and treasurer, E. M. Stack; W. F. Hallstead, M. W. Collins, Theodore G. Wolfe, Franklin Howell.

McKEESPORT.—The People's Ice, Light & Storage Company, of this place, is installing two 425-kw., 2200-volt Bullock alternating-current generators, two 640-h.p. Erie Ball compound engines, a Westinghouse exciter, a General Electric converter, and a Walker switchboard panel, to furnish light and power for the town.

SCRANTON.—The stockholders of the Suburban Electric Light Company have elected officers and directors as follows: President, A. L. Snowden; vice-president, G. M. Hallstead; secretary and treasurer, E. M. Stack; F. E. Platt, W. F. Hallstead, M. W. Collins, F. B. Bull, B. Moses and A. L. Francois. The old board was reduced.

UNIONTOWN.—The agreement of merger and consolidation, whereby eleven electric light companies have been consolidated, forming the Western Pennsylvania Electric Company, has been recorded. The capital stock is $337,500. The officers are: President, William S. Kuhn; vice-president, Jacob Van Wagener; secretary, Jesse H. Purdy, and Treasurer, John F. Cockburn, all of Pittsburg.

WILKESBARRE.—Contracts for new machinery and engines have been let by the Wyoming Valley Gas & Electric Company as a step toward the improvements the company is promising to residents of the West Side. The contracts call for an expenditure of about $50,000. It is also understood that the Wyoming Valley Gas & Electric Company has secured control of the Hazleton Gas Light Company, which is capitalized at $125,000.

HOMESTEAD.—Homestead is to have an independent electric light company, with George S. Debolt and W. S. B. Hays as its promoters. Announcement of the formation of a stock company was made recently, and it was stated that work on the erection of the plant would be commenced within a short time. Light and power will be sold in Homestead and surrounding boroughs, and power furnished to the Homestead & Mifflin Street Railway Company.

YORK.—It is stated that the newly organized Susquehanna Electric Power Company will establish an electric power plant at Conawingo Falls, in the lower Susquehanna River, during the coming spring. The company is capitalized at $12,000,000. They have secured the necessary grants of land on both sides of the river, with a view to beginning operations as early as possible. It is said that these falls will produce an enormous horse-power. A large reservoir will be built, which will serve to store water enough over night to assist the plant in the day time. The reservoir will be several miles long. Capitalists from New York, Philadelphia and Baltimore are behind the project.

RHODE ISLAND.

WICKFORD.—The Wickford Light & Water Company, which recently purchased the electric light plant here owned by H. S. Dixon, is having transformers and other apparatus placed in position. The plant will be connected with the power house of the Sea View Railway Company, which will in the future furnish the electric lights of Wickford.

PROVIDENCE.—Arthur B. Lisle, assistant manager of the Narragansett Electric Lighting Company, of this city, has resigned to engage in a brokerage business. Mr. Lisle has been with Mr. Marsden J. Perry, president of the company, as confidential clerk for about six years. He was also treasurer of the East Providence Water Company, and is interested in the Putnam (Conn.) Water & Lighting Company.

SOUTH CAROLINA.

DARLINGTON.—Reports are to the effect that the new owners of the Darlington Light & Water Company propose enlarging the plant. The company also contemplates installing a plant at Timmonsville.

SOUTH DAKOTA.

SPEARFISH.—The Homestead Mining Company is said to have purchased the Spearfish Electric Light & Power Company, the consideration in the transaction being $18,000.

MANDAN.—George Horn has sold out his interest in the Cavalier electric light plant to James Lang, who is now the sole owner. The plant will be enlarged and improved.

LEAD.—The Belt Light & Power Company contemplates installing three 500-kw. units, complete with boilers, etc., and 1000-h.p. in motors. Twenty miles of new power lines will be constructed also.

MARION.—The Marion Town Council has awarded to J. A. Heeren and other business men a franchise for the installation and operation of a lighting system. A water works system will also be constructed.

MADISON.—The municipal electric light plant is to be remodeled. Another boiler will be installed in the power house and a station regulator for the series incandescent street lighting will be added to the equipment sometime during the year.

TENNESSEE.

COLLIERVILLE.—It has been voted to issue bonds for the construction of an electric light plant.

ROCKWOOD.—A 180-h.p. engine will be installed in the city electric light plant during the summer.

SHELBYVILLE.—Correspondence is invited by the city of Shelbyville, looking to the installation of an electric light plant by the city.

COOKVILLE.—The contract for the electric light plant has been awarded to McDonald, McCoy & Co., of Chicago, on a bid of $25,159.

PULASKI.—The City Electric Light Company finds it necessary to increase the capacity of its plant, and the present equipment will be displaced by larger machines.

KNOXVILLE.—It is expected that the Knoxville Power Company will probably commence the construction of its power plant sometime during the coming summer.

BRISTOL.—Edward Durham, of Philadelphia, and W. B. Cutler, of Buffalo, have secured a franchise from the city to construct and operate an electric light plant.

HUNTINGTON.—The Mayor and Board of Aldermen have closed a deal with W. J. Holman, by which he takes charge of the city's electric light and water plant on a five-year lease.

BROWNSVILLE.—The Burt-Smith Company, owner of the electric light plant, contemplates installing during the year a 150-kw. dynamo, and will make other important improvements.

MURFREESBORO.—J. H. Nelson, proprietor of the local electric light plant, states that he expects to substitute at once an arc-light system for the present incandescent street lights.

JEFFERSON CITY.—The Jefferson City Electric Light Company, whose plant was destroyed by fire in January last, has purchased the Forche tannery property and will erect an electric light plant thereon.

NASHVILLE.—The City Council has passed an ordinance appropriating $12,600 for the purchase of a generating unit and $2500 for an arc lamp transformer, to be installed in the municipal electric light works.

DICKSON.—William McDonough, proprietor of the Dickson Machinery Repair Company, is making arrangements to put in an up-to-date electric light plant, which will enable him to furnish light to business houses and residences.

MEMPHIS.—The Merchants' Light & Power Company has been granted a thirty-year franchise by the City Council, in exchange for which the new company gives to the city of Memphis fifty arc lights to be erected along Main Street. The company is capitalized for $50,000, and will shortly be in the market for general equipment, the franchise granting the right to build and operate both gas and electric lighting and power systems.

CHATTANOOGA.—It has been announced that a lock-and-dam power plant, which will produce 30,000 horse-power will be erected at a point in the Tennessee River, near Kelly's Ferry, Chattanooga, Tenn. For some time the Government dredging boats have been busily engaged in dredging the river at Kelly's Ferry to determine the kind of foundation which may be secured for the dam. It has been found that a stone foundation is located in the bottom of the river, near the Ferry, and there the lock-and-dam power plant is to be erected by C. E. James, of this city, and Eastern capitalists. The Iona Cement Works, of Kansas, has purchased valuable lands near the site of the proposed plant, and a cement plant will be erected there with a capacity of 100 barrels per day as soon as sufficient power can be secured to run the plant. It is given out that work will actually begin on the new plant as soon as the spring freshets are over.

TEXAS.

LONE OAK.—W. R. Harrison is said to be contemplating the installation of an electric light plant here.

HAMILTON.—The Hamilton Light & Ice Company has been organized and incorporated with a capital of $20,000, for the purpose of establishing an electric light and ice plant. W. A. McSpadden, of Cisco; J. A. Muhl, of Waco, and C. Schuwirth, of Dallas, are among those interested in the project.

UTAH.

PRICE.—It is reported that a large electric plant is to be erected in Huntington Canyon, near this place. The projectors, D. C. Robbins and associates, are also getting rights-of-way over the roads of the county for an electric road.

SALT LAKE CITY.—The Utah Light & Railway Company recently made application to the City Council for a 50-year extension of its franchise, although it will be 42 years before the present franchise expires. The City Attorney, however, submitted an opinion to the Council, holding that that body cannot legally grant the application for such an extension. Samuel Newhouse, a large mine owner, submitted a counter proposition in which he stated that if given a franchise he would guarantee to furnish better light at from 25 to 30 per cent. lower than the rate now charged by the lighting company. Mr. Newhouse has deposited a certified check for $10,000 as evidence of good faith and announced that he will expend from $500,000 to $1,000,000 on his proposed steam-power plant.

VIRGINIA.

LYNCHBURG.—The City Clerk writes that a committee is looking into the matter of constructing a municipal electric light plant.

WINCHESTER.—Dr. H. H. McGuire is chairman of the committee which has under consideration the question of constructing an electric light plant, at a cost of about $25,000.

WASHINGTON.

BLAINE.—The Council has granted to H. L. Jenkins a franchise for the establishment of an electric lighting plant.

EVERETT.—The Everett Railway, Light & Water Company was recently incorporated at Wilmington, Del., with a capital stock of $2,000,000.

SOUTH BEND.—J. M. Entier has been granted a forty-year franchise to furnish electric power and lights in South Bend. Local capital is back of the new enterprise.

American Electrician.

Vol. XVII. New York, May, 1905. No. 5.

A MODERN ELECTRICALLY-DRIVEN MANUFACTURING PLANT.

NEW WORKS OF THE INGERSOLL-SERGEANT DRILL COMPANY AT PHILLIPSBURG, N. J.

The new manufacturing plant of the Ingersoll-Sergeant Drill Company, at Phillipsburg, N. J., embodies all that is recent in industrial practice, and illustrates to what an extent electricity influences modern manufacturing methods. The site is admirably located, so far as railroad facilities, abundant water supply and future extensions are concerned, and the various shops are arranged in logical sequence so that the products of manufacture pass progressively from one department to another until they finally emerge in their marketable shape.

The power house is centrally located, both with reference to the load and to the buildings which it supplies. It is built of brick and steel and is divided, as shown by Fig. 2, into a boiler and engine room. The boiler room has a maximum capacity of 2500 horse-power in boilers although but 1500 horse-power is at present installed. This is divided between three batteries, each battery consisting of two 250-horse-power Stirling water-tube boilers. Space is provided for an additional battery at each end of the boiler room. A 200-ft. Custodis stack is located at approximately the center of the building. This has an octagonal base 17 feet in diameter with an 8½-ft. flue. The boilers are fitted with Roney stokers arranged for burning anthracite slack with which is mixed bituminous slack in a proportion of about one to six. An elevated coal storage system of the Berquist suspension type is installed. This has a capacity of 1300 tons. The hoppers have a total width at the top of 24 feet and a depth of 14 feet, with a full load capacity of 7.56 tons per running foot. The delivery chutes have a measured capacity of approximately 450 pounds and are provided with shut-off valves at both ends. By this means a record is kept of the number of chute-fulls of coal delivered to the stokers, so that the coal consumption is readily obtainable. The coal is elevated from the receiving hopper and crusher in the basement to the bunkers by a McCaslin self-dumping bucket conveyor, arranged to handle either coal or ashes. A light structure is provided outside one end of the boiler room for the storage of ashes. These are received on the conveyor in the basement and are dumped through a special chute at the top to the outside elevated hopper. The conveyor is operated by a motor in the basement geared to drive the buckets at 40 feet per minute.

On each side of the stack in the boiler room is a Green economizer, one to provide for two batteries of boilers and the other to eventually serve three batteries. Feed-water is supplied by two 1000-h.p. outside-packed plunger-type Cameron pumps through a Cochrane feed-water heater supplied by the Harrison Safety Boiler Works, of Philadelphia, Pa. A 1000-h.p. Worthington underwriters' pump and a 300-h.p. Dean drip pump are also provided.

Boiler feed piping in duplicate is installed; one line running under the floor from the feed-water heater, and another line running overhead from the economizer. The two are interconnected to the feed connections at the rear steam drum. The pump connections are flexibly arranged with reference to the two lines, operating through either one or both.

The main and auxiliary steam headers are situated in a pit to the rear of the boilers and may be reached from the floor above through removable iron gratings. The main header is 14 ins. in diameter and the auxiliary 6 ins. in diameter. Both mains are interconnected and the main header is sectioned by gate valves so that if any section is disabled it may be by-passed by the auxiliary. Each boiler is connected to the steam header through an automatic non-return angle valve and a 6-in. steam line with easy bends. A gate valve is provided at the junction of this line with the header. The steam pipes to the engines pass from the header through the partition wall into the engine room basement, and thence to the engines. Condensation is cared for by drip pockets beneath the header at different points and by separators at each engine connection. The drip system is operated by an

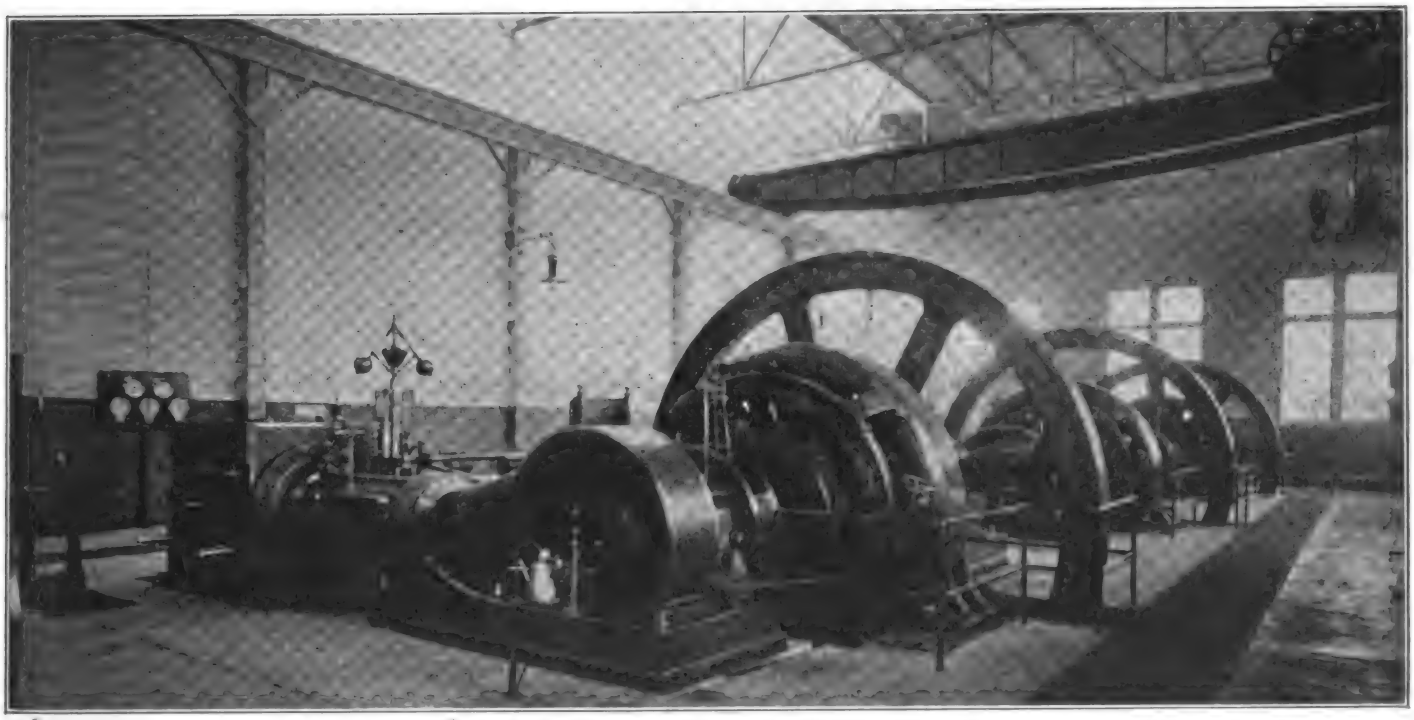


FIG. I.—MAIN GENERATING UNITS IN THE ENGINE ROOM OF THE INGERSOLL-SERGEANT DRILL COMPANY.

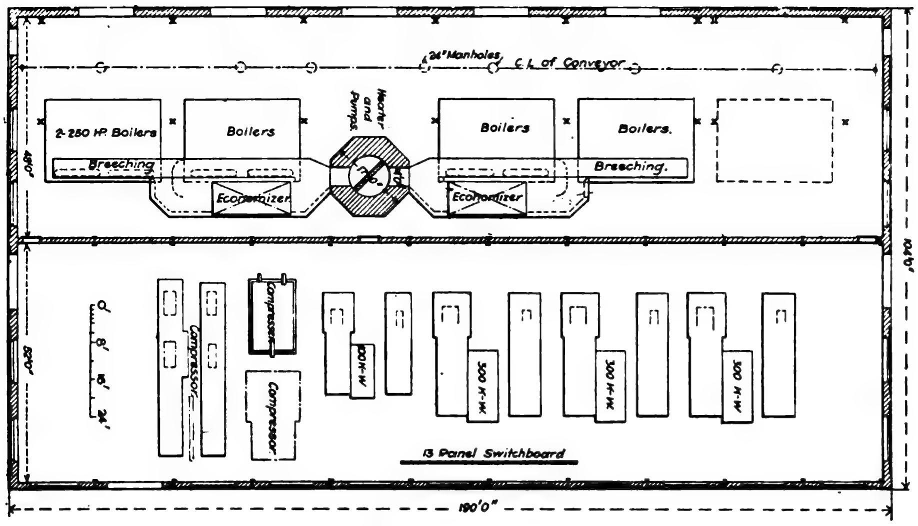


FIG. 2.—PLAN VIEW OF THE POWER HOUSE.

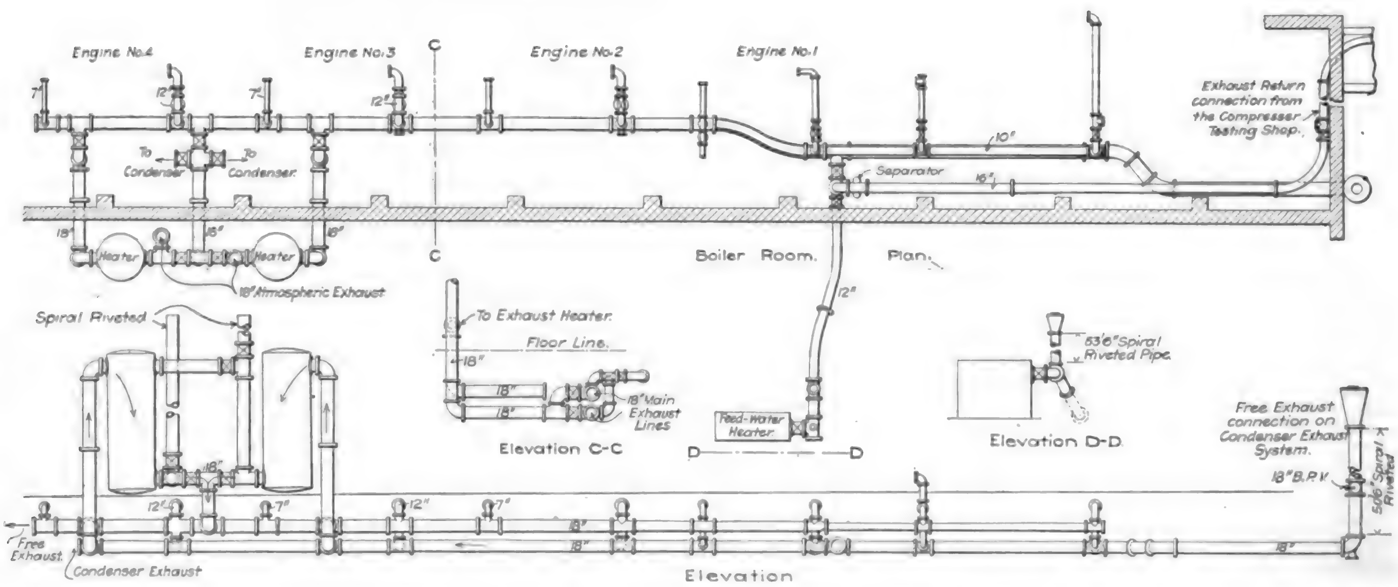


FIG. 3.—PLAN AND ELEVATION OF EXHAUST STEAM PIPING.

improved high-pressure return steam system which feeds to the boilers.

The engine room contains three 450-h.p. Cooper Corliss engines built by the C. & G. Cooper Company, of Mt. Vernon, Ohio. These engines are cross-compound, with cylinders 14¼ and 36 ins. in diameter by 36-in. stroke. They are direct-connected to 300-kw. direct-current generators furnished by the Crocker-Wheeler Company, of Ampere, N. J. A 100-kw. generator of similar type is driven by a 150-h.p. engine. Two air compressors are also installed. Two 30-h.p. DeLaval steam turbines are direct-connected to two centrifugal pumps which operate the hot water heating system for the shop buildings. The turbines are supplied with steam through special piping from one of the boilers which is equipped with a Foster superheater.

The exhaust piping system and the condensers are located in the basement of the engine room to the rear of the engines, the opening above being covered with removable iron gratings. There are two exhaust lines, one passing through the auxiliary exhaust apparatus, and the other direct to the atmosphere. These lines are both 18 ins. in diameter and are connected with each engine, the free exhaust connection being made through a Schutte automatic free exhaust valve. The line feeding to the condenser is arranged so as to permit the exhaust to pass directly into the condenser or first through the hot water heaters in the boiler room. The feed-water heater is connected to both exhaust mains.

The condensing system consists of two Conover jet condensers of 1000-h.p. capacity each. The water is pumped from a well supplied from a reservoir on the site having a capacity of 2,000,000 gallons. This reservoir or pond serves as a cooling basin for the hot condenser discharge. This passes first to a settling basin where it is freed from oil and then to the pond.

Reinforced concrete tunnels connect the various buildings with the power house. Through these tunnels steam, electricity and compressed air are supplied. The pipes are supported by adjustable swinging hangers which hook over pins fixed in the steel work of the tunnel. The wires are carried on insulators fastened to iron racks. A 10-in. main supplies steam to the air-compressor erecting shops for testing purposes and a 12-in. main carries the exhaust back to the

FIG. 4.—BOILER ROOM OF THE INGERSOLL-SERGEANT DRILL COMPANY.

condensers or heating system in the power house. The air compressed by the machines under test in the erecting shop is delivered to the power house augmenting that compressed in the latter place, thereby enabling this auxiliary supply to be used instead of being wasted. Compressed air is used considerably in all of the shops for hoists, hammers, riveters, motors and other apparatus. It is particularly useful in the foundry where it is employed in pneumatic sand sifters, tampers, tappers and chipping hammers.

The electrical distribution and drive form an interesting feature of the works. The general electrical distribution system is a two-wire system operating at 240 volts. In addition to this there are two intermediate wires in the machine shops for use in obtaining variable speeds at the motors of the motor-driven machine tools. The Crocker-Wheeler Company's multiple-voltage system of speed control is in use, and for producing the intermediate voltage a triplicate balancing rotary transformer is used, consisting of three Crocker-Wheeler machines mounted on a common base, and with the armatures on one shaft. The armatures are wound for 40, 80 and 120 volts respectively. By taking current from each of the three machines and by combining either two of them six voltages ranging as follows may be obtained: 40 volts, 80 volts, 120 volts, 160 volts, 200 volts and 240 volts. The rotary transformer is installed in the machine shop.

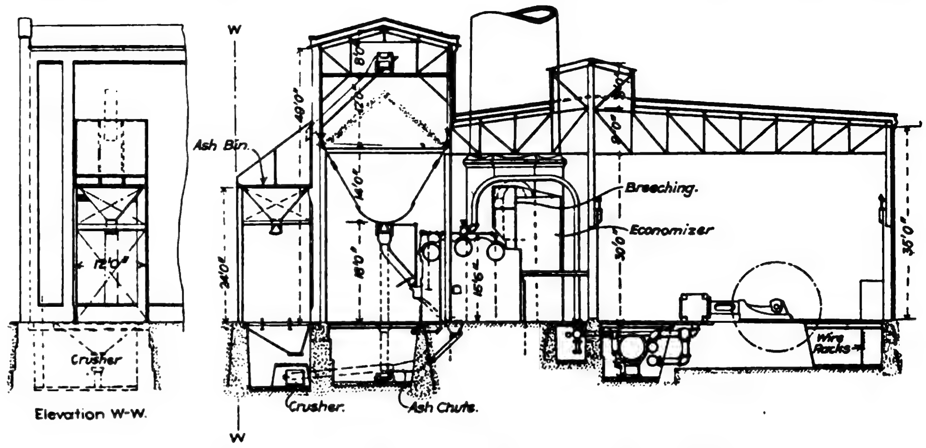


FIG. 5.—CROSS-SECTIONAL ELEVATION OF POWER HOUSE.

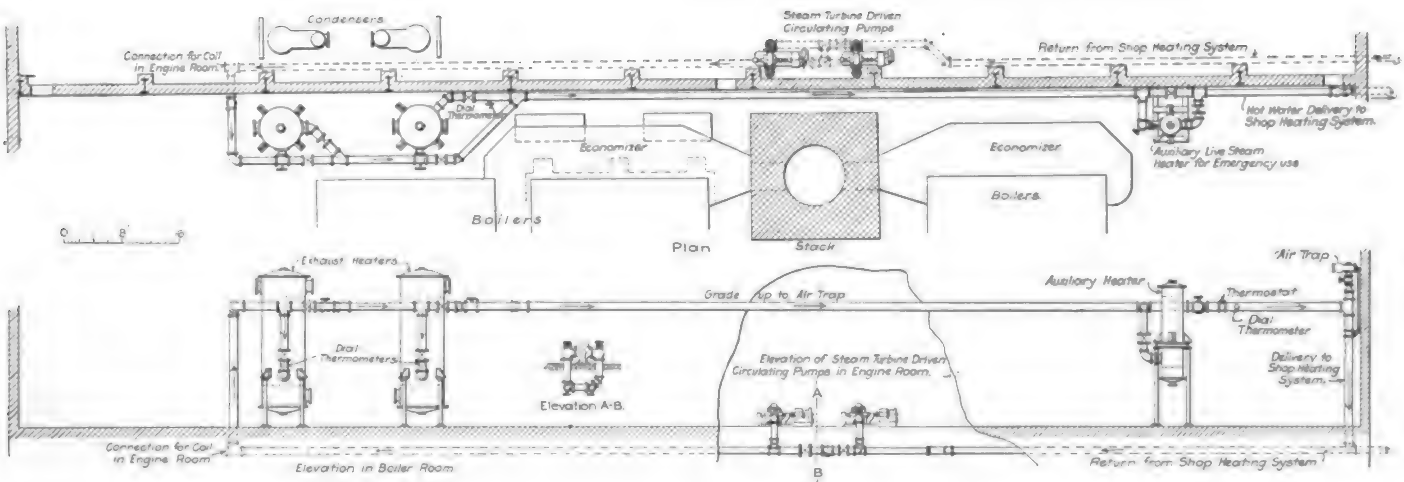


FIG. 6.—PLAN AND ELEVATION OF HOT-WATER HEATING SYSTEM.

FIG. 7.—ELECTRIC CABLES IN BASEMENT OF ENGINE ROOM.

All tools requiring a large amount of power and used on a variety of work are equipped with individual variable-speed motors. These are generally mounted on a bracket over the headstock on lathes; but in the case of planers, the motor is mounted above the housing on brackets. Heavy flywheels are used on the motor shafts for overcoming the strain on the motor at reversals of the platen. The method of driving boring mills is illustrated by Fig. 13. Here the motor is shown supported upon a bracket bolted to the rear of the housing.

In the lathes illustrated in Figs. 11 and 12 it will be noted that the drive to the headstock in each case is through gearing reductions to an intemediate shaft and from the latter to the spindle through either one of three gear changes as desired, the latter being capable of easy change. In this way an individual drive with a motor having a three to one speed range, and a suitable arrangement of change gears, will increase the effective speed range of the motor some three or four times and give the tool from 60 to 80 speeds, which will easily cover any possible class of work to which it may be subjected. The style of change gear

mechanism that supplied is that recommended by the Crocker-Wheeler Company. This mechanism provides a system of levers by which either three or four-gear trains may be thrown in, and yet so interlocked that two of them cannot be thrown in together and damage the gearing.

FIG. 8.—CABLES AND PIPES IN SUBWAY.

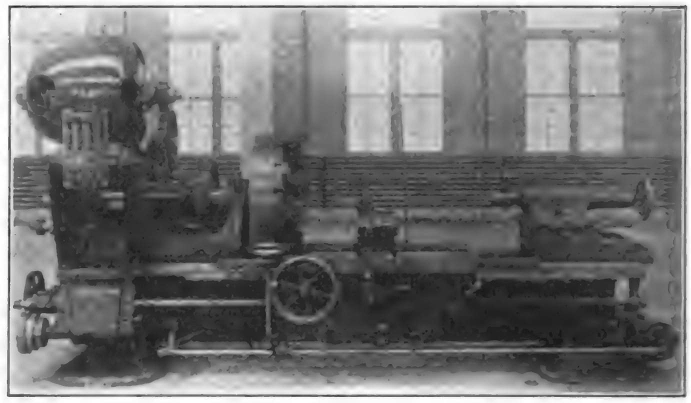


FIG. 11.—MOTOR-DRIVEN ENGINE LATHE.

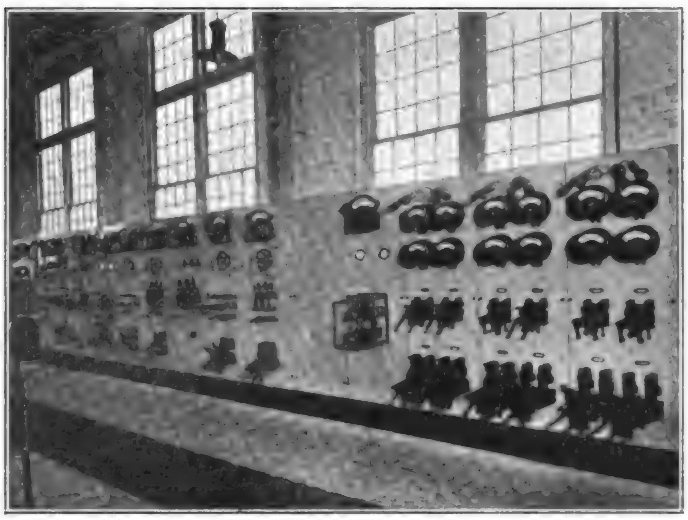


FIG. 9.—MAIN SWITCHBOARD.

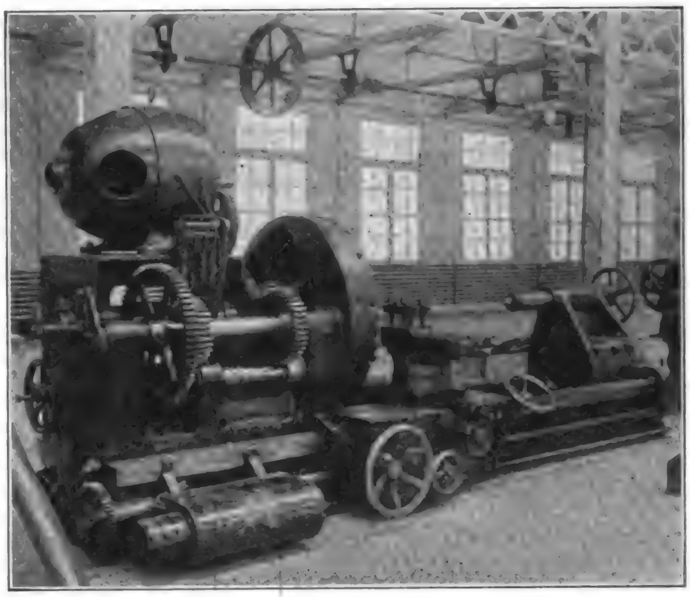


FIG. 12.—APPLICATION OF MOTOR DRIVE TO A HEAVY LATHE.

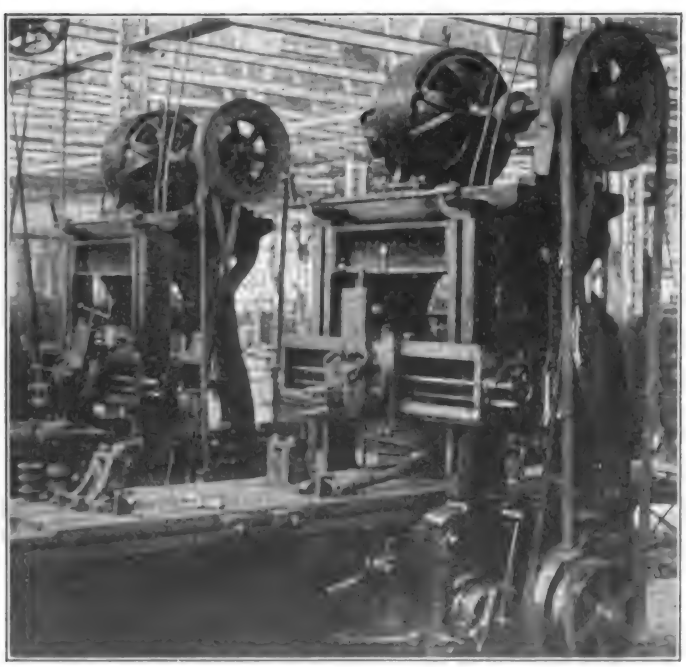


FIG. 10.—MOTOR-DRIVEN PLANERS WITH FLY-WHEELS.

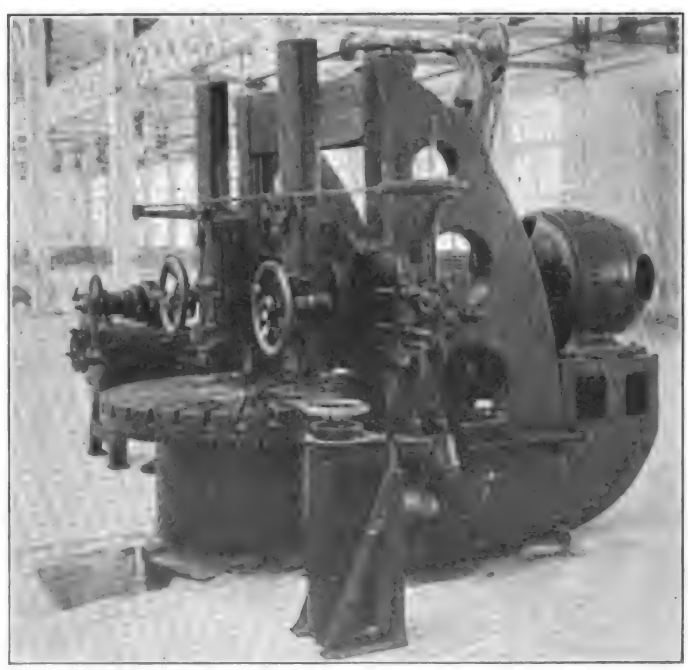


FIG. 13.—MOTOR-DRIVEN BORING MILL.

The arrangement of controllers for the lathes, which is of vital importance to the success of the method of driving, is interesting and novel. In each case the controller is mounted upon the bed close to the floor with a splined shaft either connected directly to the controller or to it through gearing. A bracket on the carriage supporting the controller hand wheel carries also the splined shaft which it turns through a sliding sleeve which keys with it, so that the controller is readily handled from a horizontal hand wheel. In the case of the boring mill the controller is mounted upon

a pedestal bracket at the side of the tool as shown.

The four wires of the multiple-voltage system are carried through the machine shop beneath the floor in bituminized conduits about 12 in. under the surface, these conduits ending in floor plate openings, adjacent to every building column. The branch leads are connected to the mains under the floor plate and run out through a short length of loricated conduit. This does not interfere with shop operations, as the floor box is covered ordinarily by a heavy cast-iron plate. The branch conduit leading up through the floor is in most cases run up alongside the nearby building column, although it is equally possible, if it is desired to locate the machine half-way between two adjacent columns, to chisel a channel in the concrete floor and locate another loricated conduit so as to lead more closely to the machine to be served.

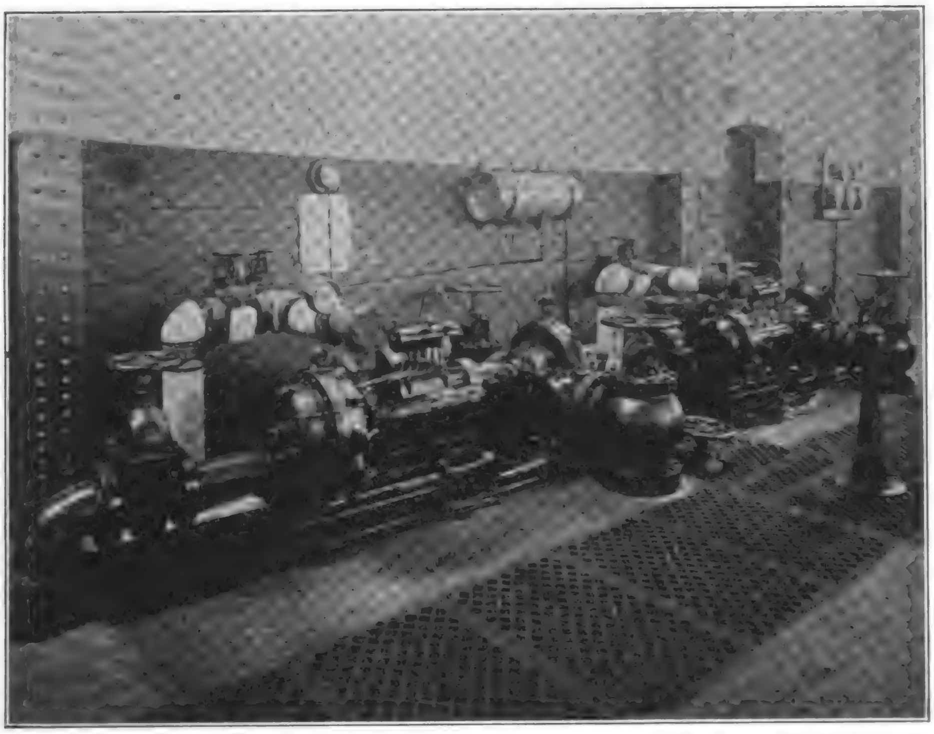


FIG. 14.—STEAM TURBINE-DRIVEN PUMPS FOR HEATING SYSTEM.

THE STEAM PIPING OF A SMALL LIGHTING STATION.

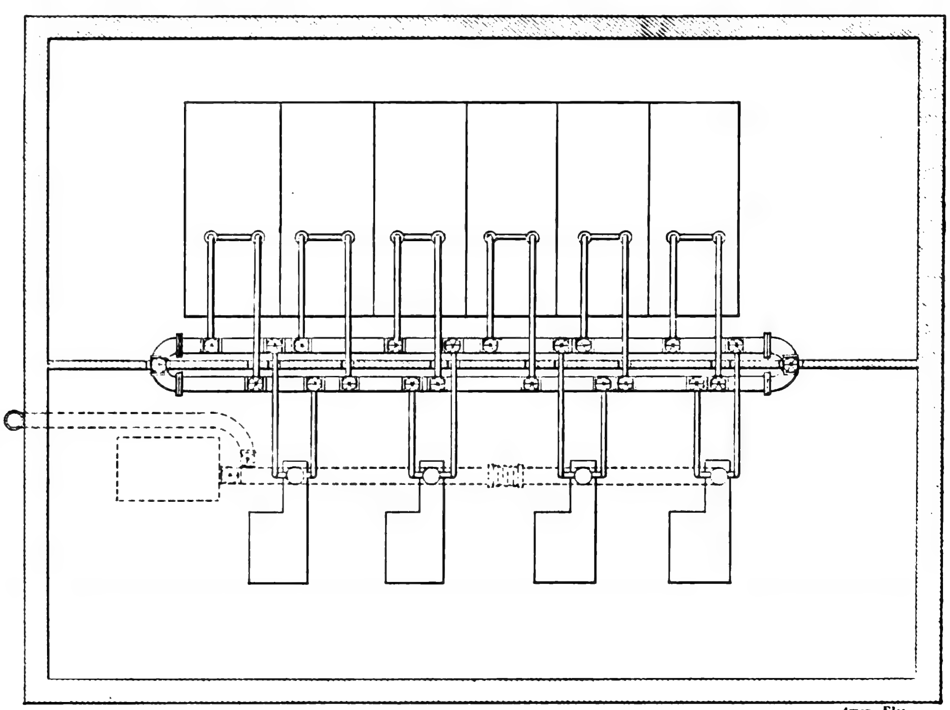
BY R. T. STROHM.

The lay out of the steam piping system of a station depends largely upon the relative location of the boiler and the engine room, and this location is influenced by the formation or shape of the ground plot upon which the building stands. It often happens that the available ground is of irregular outline, while the conditions are such as to necessitate the utilization of the entire area. This may lead to an unusual, and, perhaps, not the most desirable, lay out of the steam piping.

At present two systems are in general use. One is known as the duplicate system, and the other as the sectional or subdivided header system. Both systems embody meritorious features, and have their respective advocates; yet there is considerable difference of opinion, in many cases, as to which is preferable. The fact that both systems are used indicates that the question of superiority is far from settled.

To illustrate the first system, consider the piping of a 500-h.p. lighting plant arranged as shown in Fig. 1. The engine and boiler rooms lie side by side, and are separated by a fire wall which completely isolates one from the other. The engine room contains four high-speed automatic engines of 125 horse-power apiece, the cylinder of each engine being 12 inches diameter by 16 inches stroke, and the speed, 250 r.p.m. The plant is non-condensing.

Assume that each engine uses 30 pounds of steam per indicated horse-power per hour, with cut-off at quarter stroke and a boiler pressure of 90 pounds. There being 500 horse-power in all, the steam required per hour for the engines alone would be $500 \times 30 = 15,000$ pounds. Taking into account a possible overload of 10 per cent and allowing a further 10 per cent for the auxiliary apparatus, the total steam per hour required of the boilers would be $15,000 + (.20 \times 15,000) = 18,000$ pounds. This evaporation, on the basis of 160 degrees feed-water temperature and 90 pounds pressure is equivalent to 19,620 units of evaporation, or, as commonly expressed, about 600 boiler horse-power. This may be obtained by the use of six 100-h.p. return tubular boilers, arranged as shown in Fig. 1.



Amer. Elec.

FIG. 1.—APPLICATION OF THE DUPLICATE STEAM PIPING SYSTEM.

To find the size of steam pipe required for each engine, use the formula

$$d = D\sqrt{\frac{S \times r.p.m.}{36,000}}$$

in which

d = diameter of steam pipe in inches;
D = diameter of cylinder in inches;
S = stroke of engine in inches;
$r.p.m.$ = revolutions per minute of engine.

Substituting the several values of the known quantities, and solving, we have

$$d = 12\sqrt{\frac{16 \times 250}{36,000}} = 4 \text{ inches.}$$

In other words, the diameter of the steam supply pipe to each engine would be 4 inches.

One pound of steam at 90 pounds gauge pressure has a volume of about $4\frac{1}{6}$ cubic feet. Hence, as one boiler evaporates about 3300 pounds per hour, the discharge pipe from each boiler must be large enough to carry away a volume of $3300 \times 4\frac{1}{6} = 13,750$ cu. ft. per hour, or 230 cu. ft. per minute. On the basis of a rate of flow not exceeding 6000 feet per minute, the area of

the pipe would be 230 ÷ 6000 = .0383 square foot, or nearly 5½ square inches, which is about the area of a 2⅝-inch pipe. Inasmuch as the boiler may be forced to some extent, and as 2⅝ inches lies between 2½ and 3 inches which represent the commercial sizes of pipe, the 3-inch pipe would be chosen as the size to be used between the boilers and the main.

The main steam pipe, or header, must carry the combined discharge of the six boilers, and hence its area must be at least equal to the combined area of the six discharge pipes from the boilers. The area of a 3-inch pipe is 7 inches, so the main steam pipe should have an area of $7 \times 6 = 42$ square inches. This corresponds to a diameter of about 7½ inches, so that an 8-inch header would doubtless be used. This, it will be observed, has the same area as the four steam pipes leading to the engines, which is an additional check upon the calculations.

The header, or steam main, forms a ring which is made up of two straight, parallel lines of pipe joined at their ends by bends. One-half lies in the engine room and the other half in the boiler room, the whole being carried on a double line of brackets fixed to the dividing wall. The ring itself contains but two valves, one being placed in each of the end bends. These two main valves are provided with by-passes, for use in warming up, so as to avoid sudden strains on the cold piping.

On the boiler nozzle is fixed a Y-fitting, to which two discharge pipes are attached. One of these pipes connects with one-half of the main header, and the other pipe with the other half. Each branch pipe from the boiler consists of a long bend as shown in the sectional elevation, Fig. 2, which is connected into the top of the main by an angle stop valve. This avoids any possibility of forming pockets for the collection of water, since the condensation occurring in the bend will run back into the boiler.

Similarly, each engine has two long-bend supply pipes, one leading from each half of the main, being connected into the top of it by angle valves, as shown. These two supply pipes are connected to a separator, just above the throttle valve on the engine, the separator thus acting practically as a Y joining the two. Besides removing the entrained moisture from the steam just previous to its admission to the engine, the separator forms a steam reservoir of considerable volume from which the engine draws its supply. This acts to prevent excessive wire-drawing and assists greatly in obtaining a higher and more uniform pressure during the admission period. The use of a receiver of this kind is especially desirable on high-speed engines.

The ring, or main header, is firmly anchored at its middle point, on each side. All expansion and contraction is thus divided, half occurring in either direction. Owing to the fact that all connecting pipes are bends of long radius having considerable span, the movement of the main is readily taken up by the elasticity of the pipes, so that no further provision is necessary in regard to expansion or contraction.

It is evident from this arrangement, that the possibility of a complete shut-down is very remote, and that it could be brought about only by some extremely unusual accident. There is practically a double system of steam piping on which to depend. The boilers can be made to discharge into one-half of the main by simply closing the stop valves leading to the other half, and the engines may be made to take their steam from either side, by a similar procedure. Thus, in case of damage to the main header in the engine room, the two main valves in the end bends would be closed as well as all angle valves on the damaged half. This would cut out of service the broken section, yet would not interfere in the least with continuous working.

The diameter of the exhaust pipe from each engine is found by the formula

$$d = D\sqrt{\frac{S \times r.p.m.}{24{,}000}}$$

in which the letters have the same significance as in the previous formula for finding the diameter of the live steam pipe, with the exception of d, which represents the diameter of the exhaust pipe. Substituting the various known values, it will be found that $d = 5$ inches. As there are four engines, the area of the main exhaust pipe must be four times that of a single pipe from one engine, so that a 10-inch exhaust line is required.

The exhaust pipe from each engine passes vertically downward through the flooring of the engine room, and connects with the main. The latter conveys the exhaust steam to a feed-water heater, in which as much of the heat as possible is given to the boiler feed-water. The remainder of the exhaust is led to a vertical pipe just outside the wall, which extends upward, terminating in an exhaust head somewhat above the level of the roof. A by-pass is provided in the main so that the steam may be passed directly into the atmosphere around the heater, in case the latter requires cleaning or repairs. Provision for expansion or contraction of the exhaust main is made by inserting a corrugated expansion joint, as shown in the plan, Fig. 1. Each exhaust pipe is fitted with a valve which may be closed when the engine is out of service, thus preventing the exhaust from the other engines from backing up into it.

The main steam pipes and the separators are furnished with drip pipes connected to steam traps, which collect and deliver all condensation and entrained moisture to the feed-water heater. This is an open heater and contains provision for the separation of oil from the engine exhaust and auxiliary exhaust. It is also provided with a float for regulating the influx of cold water to supplement the condensed exhaust, according to the demands made upon the heater by the boiler feed pump. The drip pipes from the high-pressure steam pipes are all well protected by non-conducting coverings.

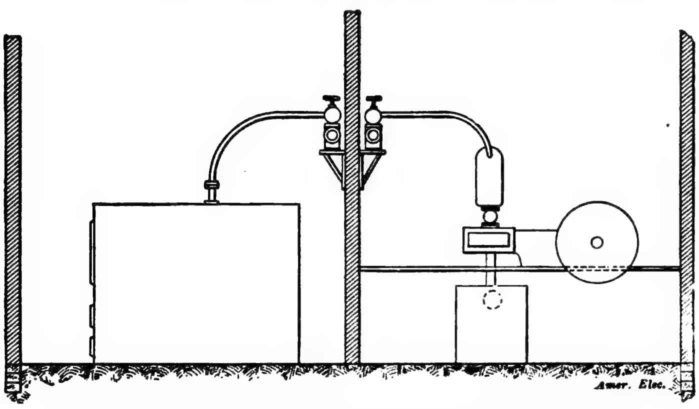


FIG. 2.—ELEVATION OF DUPLICATE STEAM PIPING SYSTEM.

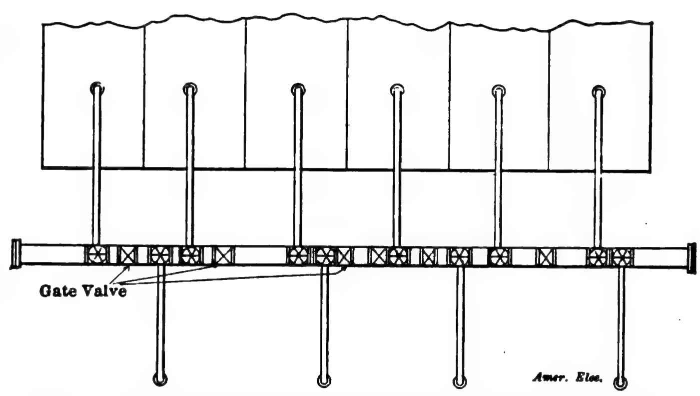


FIG. 3.—APPLICATION OF THE SECTIONAL SYSTEM STEAM PIPING.

If the system of sectional subdivision is employed, the ring header is replaced by a single straight main supported on the boiler room side of the division wall, as in Fig. 3. This main is connected to each boiler and to each engine by long, easy bends. The valves used are gate valves throughout and are located so as to divide the main into a number of sections, as shown. In case of failure of any section, the valves at each end of it are closed, as well as the valves in the discharge pipe leading from the boiler or boilers which feed into the section. Thus, the remaining engines may be run by the boilers not cut out, which likewise prevents complete shut-down.

The plant is thus divided into two distinct portions, each cut off from communication with the other. This is the one objection which can be urged against this system of piping. There can be no intercommunication of boilers and engines located on opposite sides of the broken section. There are many points in favor of the sectional system, however; first, it is cheaper to install than the ring system; second, its arrangement is far simpler; third,

it is less liable to leakage on account of the smaller number of joints; and, fourth, it may be put up in less time and with less labor.

The duplicate, or ring system, possesses the same advantages of freedom from shut-down of any portion of the plant and the ability to run any or all engines from the entire battery of boilers, as required. Against it may be rightly urged the increased cost of installation; greater loss due to increased radiating surface; added complexity of arrangement; and doubled expense in the matter of supports and drip piping. There are certain conditions under which it is not advisable to install anything but the duplicate system, but for plants consisting of a considerable number of units of the same size and type, the sectional system commends itself as the most desirable to use.

A COMPARISON OF COMMON METHODS OF MAGNET COIL WINDING.

BY CHARLES R. UNDERHILL.

The chief aim in modern electromagnet coil winding is to obtain the greatest amount of copper in a winding, with the least amount of insulating material, without sacrificing the dielectric strength of the insulation on the wire. As a basis on which to compute the ratios between the copper and insulation in the methods of winding under discussion, a winding volume of one cubic inch is assumed. For the sake of simplicity, it is assumed also, for this particular case, that the loss at the ends of the winding, due to the change in direction in the turns of each layer from right to left and *vice versa*, is negligible. The weight of wire and insulation that will just fill a bobbin accommodating a cubic inch of material may be expressed as "pounds per cubic inch." Likewise the resistance may also be expressed as "ohms per cubic inch." It is therefore obvious that having found the weight or resistance per cubic inch of winding volume, the total weight

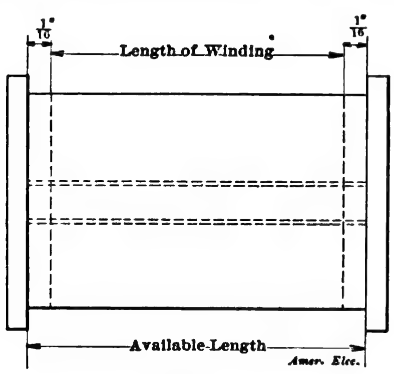


FIG. 1.

or resistance for any bobbin may be calculated by multiplying the volume of the winding in cubic inches by the weight or resistance per cubic inch.

The wires commonly used in practice are round, and in this article a round copper wire is always meant unless otherwise stated. If the ideal condition could be realized, the insulation on the wire would be so reduced as to occupy no space at all, but still retain its insulating qualities. With this ideal condition, only the actual copper need be considered. If a bobbin were wound with various sizes of bare wire the weight of the wire would always be the same, regardless of the diameter of the wire, the "pounds per cubic inch" being constant.

The most common method of insulating wires is to cover them with silk, cotton or paper, and where the coil is subjected to much heat asbestos is used. Another method, generally known as the bare wire

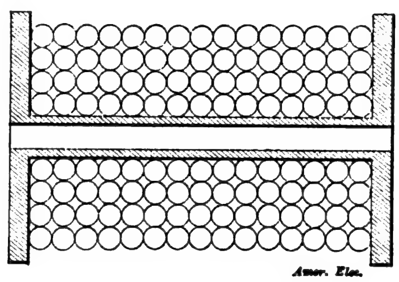


FIG. 2.

winding, consists of turns of bare wire insulated from each other, as the wire is coiled into the winding by a silk or cotton thread parallel with the wire, both being wound on simultaneously. The layers are separated from each other by suitable sheets of paper. Sometimes the silk or cotton thread is omitted and a wax or varnish used to hold the turns of wire in place and to insulate between the turns. In this case, as in the preceding one, paper is placed between the layers.

A method which has been the object of much experiment is to cover the wire with a thin uniform coating of flexible insulating compound which shall be hard enough to prevent being cut through by other turns of the winding and yet be so pliable as not to chip or crack when bent at reasonably low temperatures. Furthermore, the coating of compound should not be materially affected by heat.

For wires between Nos. 20 and 36 B. & S. gauge, the diameter of the cotton insulated wire is usually 4 mils over the diameter of the bare wire, and the increase in diameter due to silk is usually 2 mils, although on the finer wires 1.5 mils increase is often used.

In the so-called bare wire method the least distance between the turns of wire, edge to edge, is 3 mils for sizes from No. 34 to No. 40 B. & S. gauge and approximately one-half the diameter of the wire for larger sizes. The paper commonly used for this purpose is approximately 1 mil thick, and as it is necessary to use two thicknesses of paper between each layer the distance between the layers, edge to edge, is 2 mils. The increase due to the compound on the enamelled wires is sometimes less than 1 mil, making it far superior to any of the other methods as to the amount of copper that may be obtained in a given winding volume.

In the so-called bare wire winding an allowance of at least 1/16 inch must be made at each end of the winding for small coils and a greater allowance for larger diameters and coarser wires. Thus for an ordinary ringer magnet, where the winding length for a silk or cotton-covered wire winding would be 2⅛ inches, the winding length for the so-called bare wire winding would be 2 inches, which makes a loss in the winding volume of over 6 per cent. For a coil 1⅛ inches long and of the same diameter, the loss would be 12½ per cent. This will be understood by reference to Fig. 1. In the theoretical or ideal bare wire winding, there would be a certain imbedding of the wires which would amount to 7.3 per cent. With the silk or cotton insulated wire, however, the insulation spreads laterally, due to the vertical tension during the winding process, so that this imbedding may be neglected for the finer sizes of wire. There is no appreciable imbedding of the bare wire winding with paper between the layers as the paper tends to prevent this.

In comparing the economy of the different methods of insulating and winding coils with each other and with the theoretical bare wire winding, no imbedding will be assumed, but the wires will be considered to lie as in Fig. 2. The longitudinal cross-section of the winding may then be considered as consisting of a great many squares, each square representing the space occupied by each turn of wire and its insulation, as in Fig. 3. The total number of turns, then, for any given size of wire and fixed winding volume will be equal to the available cubic space divided by the space occupied by each turn of wire, the cross-sectional area of each turn including insulation space being considered the square of the diameter of the insulated wire for covered wires, and the product of [the diameter of the bare wire + the lateral insulation] × [the diameter of the bare wire + the vertical insulation] for the so-called bare wire winding.

To ascertain the total length of wire in a winding, the average length of all the turns is multiplied by the number of turns. The resistance of the winding is then equal to the "ohms per inch" for the wire multiplied by the total length of the wire in inches. Likewise, the weight of copper in the winding will be equal to the "pounds per inch" for the wire multiplied by the total length of the wire in inches. As the

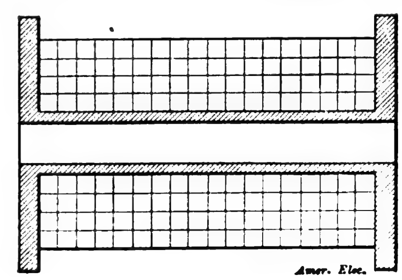


FIG. 3.

resistance of a wire is inversely proportional to the square of its diameter, while the space it occupies is also inversely proportional to the square of its diameter, the "ohms per cubic inch" for any size of bare wire in the ideal case would be inversely proportional to the fourth power of its

diameter. In practice, however, the space occupied by the wire and insulation is greater than the square of the diameter of the wire, and therefore the "ohms per cubic inch" will not vary in the same ratio as for the ideal bare wire winding, and consequently so much resistance cannot be obtained in the same winding volume. In any case, the "ohms per cubic inch" are equal to the "pounds per cubic inch" multiplied by the "ohms per pound."

Fig. 4 is a chart showing the relative weights of copper which may be obtained with the various methods of insulating and winding. The values in the curve for the so-called bare wire winding with paper between the layers must be reduced by varying percentages according to the ratio of "actual length of winding" to "available winding length," or the length available for a covered wire winding.

The magnetic effect due to any winding is proportional to the ampere-turns in the winding, and since, for fixed dimensions, the resistance of the winding is directly proportional to the number of turns, the ampere-turns will be constant for a given diameter of wire and fixed voltage, regardless of the number of turns or resistance, neglecting changes in specific resistance due to temperature variation. For example, assume a winding of such dimensions and size of wire that the average resistance per turn of wire is one ohm, and that with a very thin insulation one is able to obtain 10,000 turns of wire in the winding. With a terminal e.m.f. of 100 volts the current will be 0.01 ampere and the magnetizing power 0.01 × 10,000 = 100 ampere-turns. Now, if the same bobbin be rewound to the same dimensions as before with the same size of wire, but with so thick an insulation on the wire that only 100 turns can be got into the winding, the resistance will be 100 ohms and the current 1 ampere, but the ampere-turns will be 100 as before. In the first case, however, only 0.01 ampere and 100 volts, or 1 watt, were required to produce 100 ampere-turns in the winding, while in the latter case 1 ampere and 100 volts, or 100 watts, were required for the same number of ampere-turns.

It is therefore evident that the economy of operating a copper wire electromagnetic winding depends upon the thinness of the insulating material, or, to be exact, the degree of utilization of the available winding space for the copper conductor.

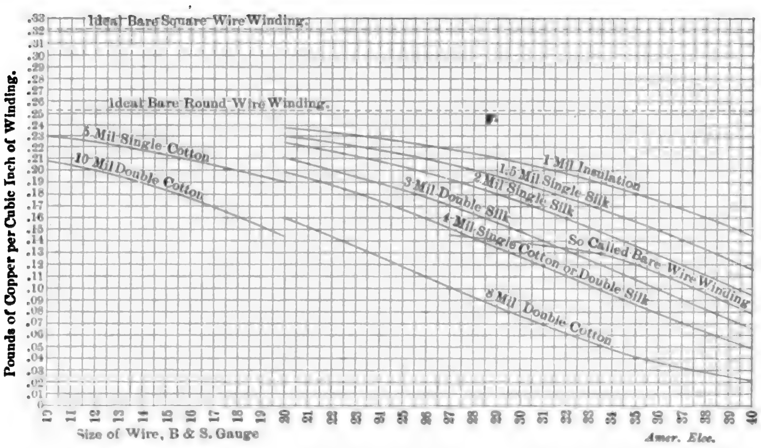


FIG. 4.—CHART SHOWING RELATIVE WEIGHTS OF INSULATED COPPER WIRE.

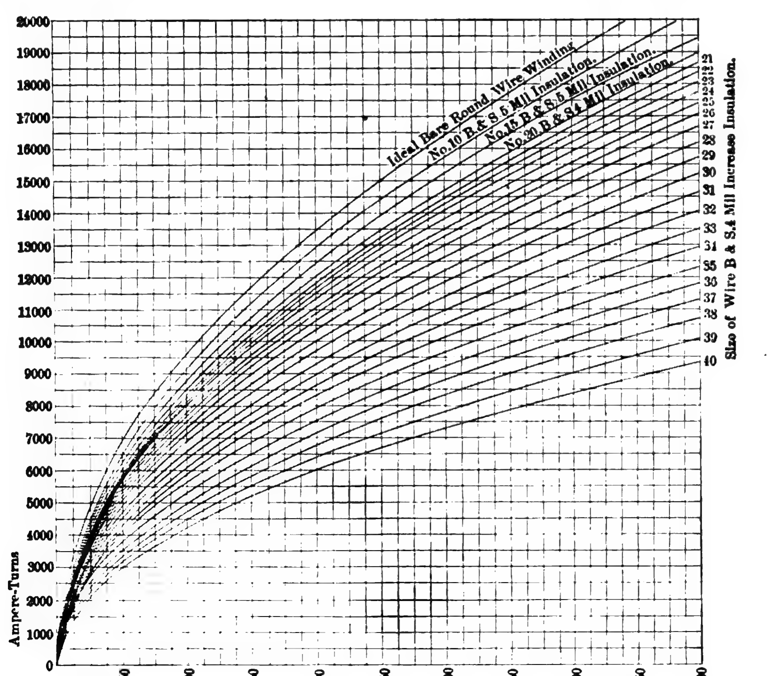


FIG. 5.—CHART SHOWING RATIO BETWEEN WATTS AND AMPERE-TURNS.

Fig. 5 shows the ratio between watts and ampere-turns for a specific case, with various B. & S. gauge copper wires insulated to a 4-mil increase. The dotted curve shows the watts required with the ideal bare round wire winding for any diameter of wire, this being constant since the insulation is zero. This shows very plainly why a bobbin wound for a given number of watts on a high voltage will not produce the same magnetic effect for the same number of watts on a much lower voltage.

AUTOMATIC BLOCK SIGNALS.

BY RALPH SCOTT.

The Taylor Electric Interlocking Signal.

In the Taylor interlocking signal system the following apparatus is used: (*a*) A storage battery or other similar source of electrical energy. (*b*) An interlocking machine, in which the circuit controllers of the various switches and signals are connected with mechanically interlocked levers, this machine being provided with electromagnetic indication arrangements. (*c*) Insulated wires for conducting current to the various motors, on the switches and signals, from the circuit controllers of *b*. (*d*) Switch and signal motors or other electromagnetic devices provided with means for opening the circuit operating the switch or signal devices immediately after these have performed their proper movement and are located in position. These are provided with the necessary means for closing the indication circuit at the same time. (*e*) The switches and signals to be operated.

In Fig. 72 the various connections of the battery, interlocking machine, indicating mechanism, circuit controllers and switch and signal motors are shown, together with a switch, a two-arm home signal, a distant signal, and a dwarf signal.

The interlocking machine forms the arrangement by which all of the various devices are required to fulfill their functions.

Each of the levers of the interlocking machine, of which four are shown in the engraving, is provided with a cam slot by means of which a motion of the tappet bar is transmitted, which motion is intermittent, according to the longitudinal position in which the cam slot is machined.

Interlocking between the various levers is effected by these tappet bars; that is, unless they are in the correct positions it will be impossible to move any of them. If the tappet bars are cross-locked in such a manner that in order to move lever 4 levers 1, 2 and 3 must be moved in the order given, it would be impossible to move lever 4 if this order were in any way changed.

The circuit controllers, indicated in the figure, consist of metallic steps, which are carried on movable blocks of insulating material, connected to the levers which make contact with the brushes supported on fixed blocks.

As will be evident from the figure, during the first quarter of the travel of the lever the tappet bar is moved through one-half its stroke by means of the cam slot. This movement makes no change in the

connections on the circuit controller, the contact pieces merely sliding along the same brushes. This movement, however, causes the preliminary locking of the controller routes which conflict with the new motion of the lever.

At the half and three-quarter positions of the lever the contact pieces are carried from the brushes at one end of the controller to the brushes at the other end. The tappet bar, however, during this motion, remains stationary, the lever being stopped for a short time at this point by the latch, *L*, until released by the indication magnet, *I*. When the indication magnet releases the lever, it requires but a slight pull to move the latter to the end of its travel.

During this final quarter movement of the lever the electrical connections are unchanged, being the same as at the end of the third quarter of the stroke.

The tappet bar, however, is moved to the end of its stroke and releases the other levers which do not conflict with the new position to which the lever is moved. The switch movement is controlled by means of two wires and the main common wire.

The indication currents generated by the switch motor itself during its revolution are transmitted through the same wires and the indication common wire. In one position of the lever one of the wires is the control wire, and in the other position it is the indication wire. When the lever is moved to the other position, this order is reversed. Each of these latter wires is connected to two brushes of the circuit controller, one brush at each end.

The controller, therefore, reverses the connections of these wires so that in one position of the lever one is connected to the positive end of the battery in series with the safety magnet, *S*, and to the operating bus-bar; while the other end is connected to the common indication wires through the indication magnet, *I*, and to the indication bus-bar. In the other position, these connections are reversed. By means of the pole-changing switch, *P*, located in the switch itself, the switch is also controlled.

This pole-changer is automatically shifted by means of the switch lock bolt, during the latter part of its movement, and after the latter has passed entirely through the lock rod, connection being made between the movable part of the pole-changer and the mechanism represented at the rod. This pole-changer has two movable contacts and eight fixed contact points.

The armature terminals are connected respectively to two of these fixed contact points. One field terminal is similarly connected to two other of these points, each of the control wires being connected to the two remaining points. The other field terminal is connected to the common main wire.

These connections are made in such a manner that in one position of the pole-changer one of the armature terminals is connected to one of the control wires and the other armature terminal is connected to the field coils, while in the other position the latter terminal is connected to the other control wire and the former to the field coil. The diagram represents the connections as they normally are. The switch normal control wire in this position is connected to the battery, no current flowing, because at the pole-changing switch there is a disconnection.

If the lever, 3, is reversed, the reverse control wire is put in connection with the battery, a current thus flowing from the plus side of the battery to *K*, the operating bus-bar, the fuse wire, magnet, *S*, controller, contacts 6 and 8, reverse-control wire, pole-changer contacts, 15 and 16, the switch motor armature, pole-changer contacts, 11 and 12, the motor field coils, and then to the main common return and back to battery.

This battery is, as has been stated before, a storage battery which has been charged by means of a portable generating set, from time to time.

Current is continued until the switch has completed its movement and is locked in this latter position. Before this locking occurs, the lock rod shifts the pole-changer from contacts 15 and 16, to contacts 13 and 14, also from contacts 11 and 12 to contacts 9 and 10, thus disconnecting the reverse control wire from the armature and connecting the terminal, *a*, with the field coils and the terminal, *b*, with the reverse indication wire.

Just here a very important function is performed. As soon as the electric motor speeds up it develops a counter electromotive force; then when the current is cut off, the momentum continues the development of this counter-current, the useful function of which will be shown later.

The latter connections made by the pole-changer are such that the counter current leaves the armature at the terminal, *a*, and causes the same field flux that the driving current has caused; also passing through the main common to the indication common and through the following circuit: Indication common, magnetic cut-out, *H*, switch *J*, indication bus-bar, indication magnet, I^3, the circuit controller contacts, 4 and 2, reverse indication wire, pole-changer contacts, 10 and 9, to the terminal, *b*, of the armature, thus causing the indication magnet, I^3, to be energized, which releases the locking on the lever, 3, as follows:

Before the current passes through the magnet, I^3, the latch, L^3, is in a horizontal position with respect to the lever, 3, being held in position by the small dog, P^3, thus preventing the completion of the stroke of the lever, 3, because of the fact that the projection, Q^3, on the lever, engages with a similar projection on the end of lever L^3.

The indication magnet then lifts up its armature, T^3, which moves its plunger up and strikes the dog, P^3, in such a manner that it is thrown from under the latch, L^3, thus permitting the latter to drop and allowing the stroke of the lever to be completed. It is evident that in order that the indication current may flow through the magnet, I^3, it is necessary that the driving current must be cut off; that the indication wire must be put in connection with the armature, and also that the connections between the armature and fields of the motor be reversed.

The first of these conditions could be caused by a broken wire, the second by a cross between the indication wire and the armature wire, and the third by breaks and crosses in the armature and field wires. However, these three conditions would require a state of affairs which it might be said would be impossible of accidental creation.

It is evident that while the switch is being moved the connection between the normal and reverse control wires would cause the battery current to be sent through the indication magnet, thereby giving a false indication, but this is prevented by the following scheme:

A safety magnet, *S*, is placed directly beneath the indication magnet, I^3, the indication armature resting normally on the poles of this magnet. Since this magnet is in series with the battery, and connected to the control wires, all battery current must be sent through this safety magnet.

Were the two wires connected, the entire current, both that flowing through the switch motor and also that passing to the indication magnet, must pass through the safety magnet, so that if the entire current returned by way of the indication magnet, the current in this magnet would not be greater than the current in the safety magnet, and as the armature rests on the safety magnet itself for a short distance from the indication magnet, the latter cannot lift this armature.

If at the same time any of these wires were broken, even in the safety coils, it would cut off all current, since these are coils in series with the battery.

By moving lever 3 back to its normal position, the normal control wire is connected, through the safety magnet, *S*, with the battery. Thus, a current is sent through the switch motor, and passes from terminal *b* to the terminal *a*, through the armature which is in the reverse direction to that sent through the motor on reversing the switch; the current flowing through the fields in the same manner as before.

This reverses, therefore, the direction of rotation of the armature, the switch being moved back to the position it assumed at first. When the movement is completed, pole-changer *P* is moved back to the position shown in the figure, the indication current being generated as above shown. This current passes from the terminal *b* to the terminal *a* through the normal indication wire, the latter being formerly the reverse control wire.

As stated above, the current through the field coils is in the same direction as before. *P* is operated automatically by the lock rod in the latter part of its movement, and is also under the control of the lever by means of the magnets, *M* and *M'*. The former has one terminal connected to the main common wire, the other terminal being connected to the normal control wire. The latter magnet has one terminal connected to the main common wire, the other terminal being connected to the reverse control wire. When the normal control wire is connected to the bat-

tery, a current will flow through the magnet, *M*, while, when the reverse control wire is connected to the battery, current flows through the magnet, *M'*. These currents are sufficiently strong to cause a shifting of the pole-changer, whenever it is locked in position by the lock bolt, which is during the entire switch movement except at the first and last fractions of an inch.

Current is sent out through the reverse control wire whenever lever 3 is reversed, hence to reverse the switch motion current passing through the switch motor, in the right direction, it is necessary to reverse this switch and also the current through the magnet, *M'*.

This latter current has a tendency to hold the pole-changer in such a position that the current in the motor is maintained.

It is sometimes necessary, as is the case when the rails are blocked with snow, to put the switch back to its normal position before it has completed its reverse movement.

To do this, it is only necessary to put the lever back to its normal position, which sends a current through the normal control wire and the magnet, *M;* the magnet, *M*, being energized, the pole-changer is shifted to the other side, and into such a position that the current from the normal control wire which passes through the motor, is in a direction to put the rail switch in a normal position.

At the end of the movement, the pole-changer will be shifted back to the position shown in the diagram, the indication current being developed as shown. When the magnet, *M*, shifts the pole-changer, no current is sent through the indication magnet because of the fact that the controller connected to the lever is in the wrong position with respect to the former; and is not developed in case the magnet fails to work because of the fact that the connections between the armature and the field coils are in the wrong direction to develop it.

If they were reversed, however, this would occur; but this condition cannot happen. The circuit-breaker, operated automatically by the switch movement, but not shown in the diagram, is provided to cut off the current from the magnets, *M* and *M'*, when the switch is in either extreme position.

The foregoing description, while rather complicated, shows with what thoroughness the inventor of this system went about his work, and produced an arrangement which is remarkable for its extreme reliability in operation.

In Fig. 72, the home signal having two arms is represented as operated by one operating machine through a switch box connected to the switch as a selector, this being accomplished by the operation of one lever. Each of the signal arms is counterweighted by means of a weight at the end of a lever, to each end of which the end of a chain is attached. This chain passes around a chain sheave which is connected to and operated by the above machine. This chain sheave is provided with webs to hold the chains in their proper position, and also to grip the chain.

When the motor armature is operated in but one direction, one of these levers will be moved, while if the armature is operated in the other direction the other lever will be moved. The direction of the armature is controlled by the position of the reversing switch, which changes the contacts as required. Each of the signal arms controls, through a short rod a circuit-breaker. A circuit-breaker, operated by the home or upper arm has four contacts; one pair for controlling its motor circuit and the other pair for controlling the circuit of the distant arm, this being the case when the home arm is at the clear position.

The lower arm circuit-breaker has only two contacts, and these only for controlling its own motor, since the distant arm has no further control over any other signal arm. The signal controller, connected to the lever mechanism in the interlocking machine has two pairs of stationary contacts, one for normal connections and the other for reverse connections, this being accomplished by a sliding contact piece, which is connected to the lever and moved by the latter motion.

One of the reverse contacts is connected with the plus end of the battery, one of the normal contacts being connected to the common indication wire, the other two remaining contacts being connected with one end of the indication magnet, the other end of this indication magnet being connected to the signal control wire; one wire only being necessary for either single-arm or double-arm signal, for both control indication positions. After lever No. 2 being reversed, the control wire becomes connected with the battery, through the indication magnet, I^2, and also through the sliding contact of the circuit controller.

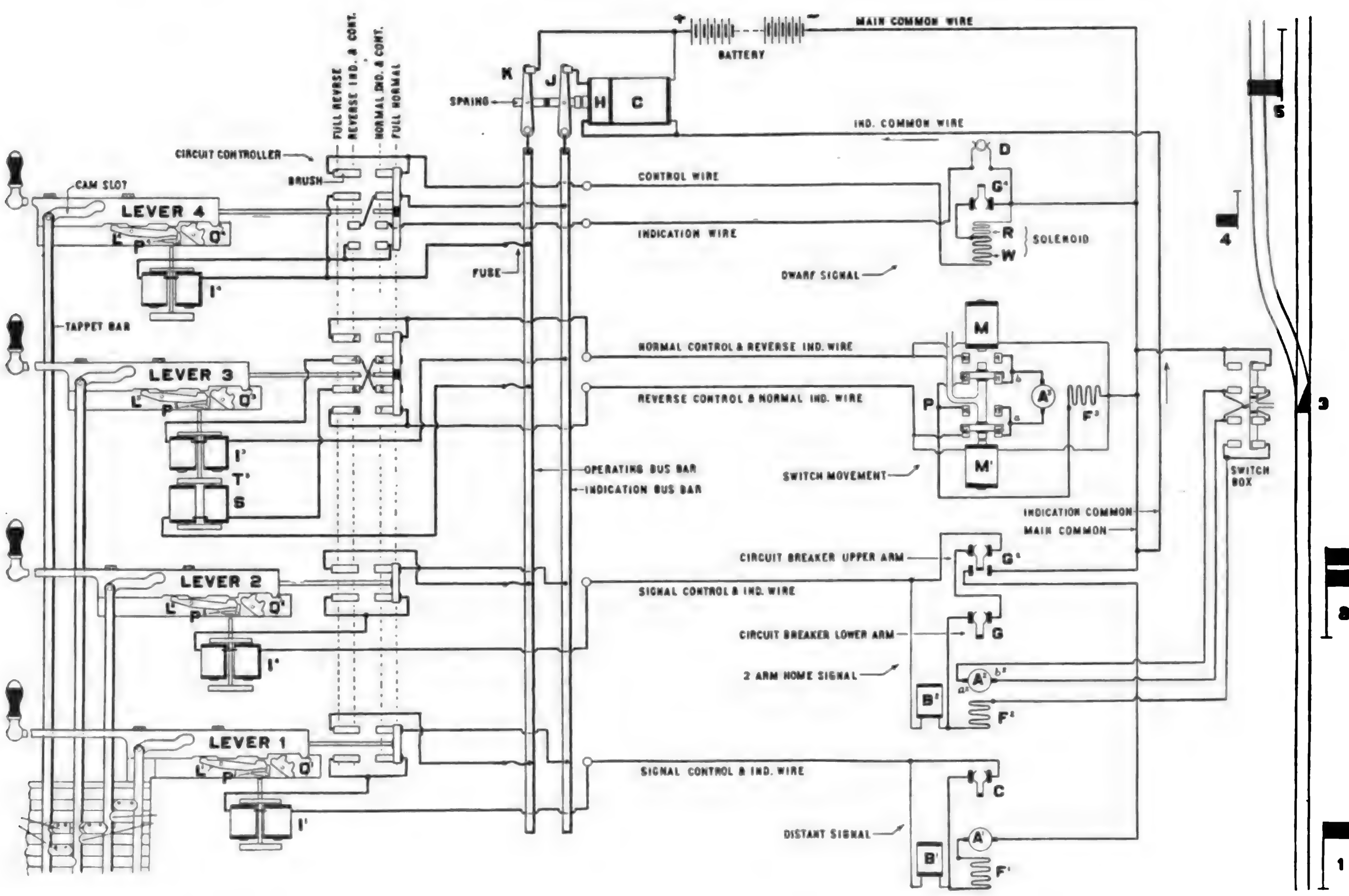


FIG. 72.—TAYLOR ELECTRIC INTERLOCKING SIGNAL SYSTEM.

This current flows through the indication magnet, the two circuit-breakers in series, the control wire, the motor field coils, F^2, one of the contacts of the switch box, the armature, A^2, and thence through another contact in the switch box to the main common.

If the switch box be normal, this current causes the armature of the motor to rotate in such a direction as to move the home arm to clear. When this home arm is at the clear position, the circuit-breaker, G^2, opens the circuit, and at the same time, during the latter part of its movement, closes the circuit of the distant signal. The circuit-breakers, being shunted by the break magnet, B^2, of very high resistance; the current is not suddenly ceased, but it is reduced to a very small figure by the high resistance of the shunt magnet.

This brake magnet, being energized, retards the disc carried on the shaft of the armature and thus brings the armature to rest. This holds the signal in the clear position, as long as the lever, 2, remains in the reverse position, to which it has been thrown. Since the current which operates the signal has passed through the indication magnet, I^2, the lever, 2, is released by the latch, L^2, and thus permitted to make its full movement to the reverse position.

However, this does not indicate that the signal has moved entirely to the clear position, but this is not necessary, since the indication of the clear position of the signal would be of little use, as no locking is released by the final part of the stroke of the lever, except that between the home and the distance signal; and this, as has been shown above, is already provided for by the circuit-breaker. which is controlled by the home signal.

When lever 2 is in the normal position the circuit to the break magnet is opened at the controller, the control wire being then connected with the indication common wire through the indication magnet. This causes the motor brake to be released and allows the signal arm to return to its normal position by the action of gravity on the counter weight.

The falling counter weight also sets the motor armature into a backward rotation, which develops a certain amount of electromotive force, then when the signal arm is nearly at its normal position, the circuit-breaker, G^2, assumes its normal position, thus closing the circuit of the current developed in the armature.

The path of this current is as follows: Leaving the armature at the brush, B^2, it passes through the switch box and the main common wire to the indication common and the coil H, then through the indication bus-bar, indication magnet, control wire, circuit-breaker, and fields of the motor, finally passing through the switch box and back to the motor armature.

This current, in passing through this circuit, causes the indication magnet, I^2, to be energized, thus releasing the lever, and allowing the final part of its movement to be made. The armature, in delivering up its energy, is caused to develop a retarding torque, thus bringing it to rest much quicker than otherwise, and also serving as a sort of dash-pot to the falling counter weight, thereby eliminating any destructive effects which might be produced were not the armature circuit closed. If at the same time that the lever, 2, is reversed, the switch box be reversed, the current, after passing through the field coils, will also pass through the switch box, and through the armature by way of the circuit, b^2, a^2.

This current rotates the armature in the right direction to clear the distant signal. The break magnet in this case is put into circuit by the lower circuit-breaker on the distance arm. When the lower arm is again in its normal position, the indication current is developed, by utilizing the rotation of the armature, in the same manner as has been described for the home arm.

This current flows in the same direction and through the same circuit, except the direction in the armature is changed, and also the two wires connected to the switch box are reversed.

In Fig. 72 the dwarf signal, with its connections is also shown. This signal is operated by a solenoid, which has two windings, one of very low resistance and the other of very high resistance. The low resistance winding is called the working coil and is shown at W in the figure. The other winding is of very high resistance and serves to retain the armature of the solenoid in the position given it by the working coil. This retaining coil is shown at R in the figure.

This dwarf signal solenoid also operates two circuit-breakers, which are controlled directly by the signal arm; one of these circuit-breakers controlling the indication circuit and being closed only when the signal is in the normal position, and the other controlling the working circuit and opening each time the signal is reversed.

The dwarf signal circuit controller, connected to the operating lever, is provided with eight fixed contact pieces, and two movable flexible contact strips. Two of these contacts are much longer than the others, and are situated at the end of the controller, connecting with the movable strip during the entire movement of the lever. The other two contacts at each end are short, and make contact with the other movable strip only when the lever is brought to a stop by the latch, L^4.

Since it would be an undue complication to derive a current from a solenoid for the purpose of indication as is done in the case of the home and distant signal motors, and also the switch motors, the indication current is obtained directly from the battery. One terminal of the indication magnet is connected always to the positive pole of the battery, the dwarf circuit controller connections being such that when the lever is at the normal indication point, the control wire is connected to the indication bus-bar, the other terminal of the indication magnet being connected to the indication wire. In the reverse indication position, the control wire is connected to the plus pole of the battery, the other terminal of the indication magnet being connected to the negative pole, through a circuit including the indication common and main common wires. In the full normal and reverse positions the control wire has the same connections that it acquires at the same indication points; the indication magnet being cut off to prevent a needless flow of current through its coils. If the lever, 4, is reversed, the control wire becomes connected to the battery, while the current flows through the working coil, W, and circuit-breaker, G^4, to the main common wire. This causes the signal arm to be moved to the clear position and also opens the circuit-breaker, which puts in circuit the retaining coil, which latter is in shunt with the circuit-breaker. The current in this retaining coil holds the signal arm in the clear position. The indication magnet is at the same time connected to the battery at the point of indication, and allows of the release of the lever to make its final movement to the reverse position. As has been shown with the high signal, this does not indicate that the signal has moved to the clear position, but in this case, also, it is not necessary to have any indication, because of the fact that there is no locking to be released, by the remainder of the movement of the lever to the reverse position.

The only reason for employing this arrangement of connections is to use a standard lever for both switch and signal levers. If the lever, 4, is forced back to the normal position, the retaining coil is short-circuited, and the signal returns to its normal position upon the lever reaching this normal position. Circuit-breaker D connects the common wire at the signal with the indication wire, and, as soon as the movement of the lever to the normal position has connected one terminal of the indication magnet with the indication wire, a current flows through this magnet, and releases the lever from the latch, L^4, thus allowing it to be forced to the full normal position.

It is evident from the number and operation of each of the circuit wires that if crosses between these should become of accidental creation, the various devices would be extremely liable to cause false indications, thus introducing dangerous factors into the system. To serve as a protection against these bad effects, the following scheme is used: J and K are two switches, electrically independent, and held normally closed by current passing through the coil C. When switch K is opened the battery is not connected in any way with the various circuits. When the switch J is open, all wires are disconnected from the indication common wire. Current passing through the coil C takes the following circuit: Plus pole of the battery, the coil, indication common, main common, and returns to battery. Another low-resistance coil, H, is wound on the same magnet core with the coil C. This coil H forms part of the indication common. All indication currents, therefore, from the signal and switch motors, must necessarily flow through the indication common, and through the coil H in such a direction that the latter assists the coil C to hold the switches closed. Since the indication common is connected to the

other, and to the main common, and this to the negative pole of the battery, then any current that might flow from the battery through the coil *H*, will pass in the opposite direction to that shown above, and cause the coil, *H*, to neutralize the effect of the current in *C*, and thus throw the switch open. By inspecting the diagram, it will be noticed that all wires that are in connection with the above coil and its functions are connected at the interlocking machine to the minus pole of the battery through the indication bus-bar, the switch and the coil, *H*, and also the indication and main common wires, so that current passing through any of these wires, on account of a cross with a live wire, will flow back through this coil *H*, in such a direction as to open the cut-out, and thus cut off current from the battery, which will render impossible any wrong movement, since we will have no current to effect this movement. The resistance of this path of the current is much less than that through the motor and main common wires; therefore, the greatest part of this current, due to a cross, must flow through the coil, *H*. The relation of the turns of the coil *H* and *C* is such that any current due to a cross and strong enough to operate the motor will also throw open the switch and cut off all current from the battery, before it can flow through the motor. The indication common wire is connected to the main common wire at some distance from the interlocking machine. The reason for such a connection is to avoid the drop in voltage in the main common wire, which occurs on working a switch motor or number of such. If this indication common wire were connected directly at the battery, this drop in voltage would tend to force the current back through the indication wires of the other magnets, not being operated, and would, in many cases, cause the switch to be opened and thus cause unnecessary annoyance and delay. By connecting the indication common at some distance from the battery at the main common, this drop in voltage is avoided and the safety factor is not lessened, since a break in either wire would open the switch.

Abstracts from Foreign Contemporaries

Cement-Covered Wood Poles.—According to Mr. M. Kastler, in the *Schweizerische Elektrotechnische Zeitschrift*, wooden poles—completely covered with a 1.5-in. to 2-in. layer of cement—have been tried and experimented with for the last three years. During this time they have proved entirely satisfactory, and it is hoped that they will be as durable as well-kept iron poles, over which they have the advantage of cheapness. The wooden pole is first surrounded by a wire netting supported from the pole by suitable iron brackets and iron bars. After this has been done the whole of the pole is covered with cement to the thickness mentioned. Such cement-covered wooden poles, in lengths of 39 ft., 42.5 ft. and 46 ft., have recently been employed by the Zurich electricity works. Before adoption some tests were made on a pole 12 meters (39 ft. 4 in.) long, having a diameter of 7-9 in. at the top and 12.4 in. at the base. The length of pole embedded in the ground was 1.6 meters (5 ft. 3 in.), and the pole was subjected to a pull at a point 10.2 meters (33 ft. 5 in.) above the ground, the force being gradually increased until the pole broke. This took place when the pull reached 1,068 kg. (2,370 lb.), and it was observed that the deflections were very nearly proportioned to the force applied up to the moment of breakage. For a force of 838 kg. (1,860 lb.), for instance, the deflection was 89 cm. (2 ft. 11 in.).

Curious Lightning Discharge Effects.—E. L. Ingram communicates to the London *Electrician* particulars concerning the curious and surprising effects of a lightning discharge in Bournemouth on March 15. At 4.30 p. m. on this date a flash of lightning struck a chimney of a house in the Richmont park road, shattered the chimney-stack and got on to the wires of the electric lighting installation. This installation is connected to the Electricity Supply Company's distributing mains, which are triple-concentric, lead-sheathed cables drawn into stoneware ducts. The cables are arranged as usual with the outer conductor neutral, and with 400 volts between the "inner" and "intermediate," the supply to consumers being at 200 volts. The neutral conductor is dead earthed at the transformer chamber, 780 yds. from the house struck, and the lead sheathing of the cables is dead-earthed in each draw box. The installation struck is connected between the inner and neutral conductors. The discharge appears to have found its way to earth through the neutral earth at the transformer chamber, in its course blowing all the distributing and main fuses of the installation struck, shattering the porcelain covers with such violence that one piece of porcelain broke a window some yards away, and blowing the cast-iron service fuse box to pieces. The meter, connected on the pressure or inner main, was burned out, and the metal cover twisted out of shape, while the incandescent lamps were curiously affected. In one case a 16-c.p. lamp, hanging by a length of silk "flex." from the ceiling, had three small holes about ¼ in. diameter burned through the glass close to the collar, the lamp globe not being burst, but the glass being very much blackened all over the inside. In three lamps of this installation the filaments were broken into short lengths and projected against the glass with such force that many of the pieces adhered to the glass and cannot be shaken off. All other installations within a radius of 430 yds., both on the inner and intermediate sides of the distribution system, had one or more lamps affected in the same way, but in no case were all the lamps of an installation damaged. In one house, 95 yds. away, connected on the opposite side of the three-wire system to the one struck, a porcelain fuse fitting was broken. There is no sign of the lightning having pierced the insulation between the conductors of the triple-concentric cable or of having jumped across in any joint box, and the insulation remains high. Nor was there any interruption of the supply by the blowing of transformer or distributing cable fuses. No shunt windings of meters were damaged except that in the house struck. There were no lamps switched on at the time in any of the installations affected.

Prevention of Excessive Pressure Rises.—The London *Electrician* describes two new devices for preventing excessive pressure rises in alternating-current systems, according to recent British patent specifications. The first is a method of the Lahmeyer Company. When machines are switched in or out, disruptive discharges may easily occur, and this principally happens in the coils or parts of conductors which are nearest to the current-supplying mains. To remove this dangerous pressure from the machine, the first coil which shows the largest increase of voltage is connected in series with a choking coil which chokes under normal working conditions the same amount of voltage as every armature coil. This action of the self-induction can be explained as follows: When the self-induction is not switched in, the coils, or parts of conductors nearest to the supply main, exert a choking action

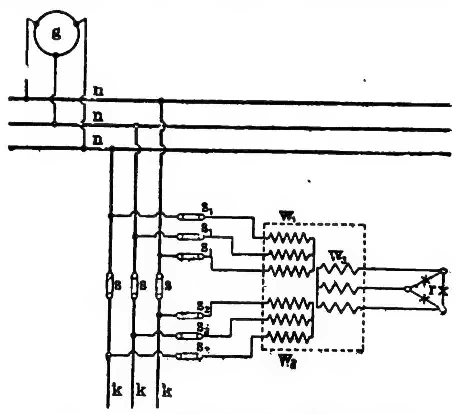


FIG. 1.—DIAGRAM OF CONNECTIONS.

when the current is turned on, so that the whole amount of excessive pressure is, so to speak, concentrated in these first portions of the coils. If, however, self-induction be switched in series with the machine, this self-induction takes up the excess of voltage. The self-induction coil can easily be so insulated that a disruptive discharge cannot occur therein. The choking coil may be short-circuited by another movement of the switch after the starting has been effected. A single choking coil may be used for several machines, this single-choking coil being switched in only

when a machine is switched in or out. The second method has been devised by Siemens Brothers & Co., and is shown in Fig. 1. *g* represents a three-phase current generator, and *n* are the network conductors, from which the cables, *k*, are branched by means of the switches, *s*. The auxiliary appliance consists of a transformer with three windings, of which w_1 and w_2 have the same number of turns, and are connected in the same direction by means of switches, s_1, s_2, respectively, before and after the main switches, *s*, to the cables, *k*. The third winding, w_3, of the transformer, on the other hand, which is advantageously arranged for low pressures, is connected to a non-inductive loading resistance, *r*, of suitable value. Assuming, in the first instance, that the winding, w_3, is open, but that all the switches are closed, then only the magnetizing current of the transformer will flow in the equal windings, w_1, w_2. As regards the conditions of magnetization, nothing will be altered if the winding, w_3, be connected up with the resistance, *r*. Practically the same pressure of the connecting points, w_1, w_2, will still be maintained if the switches, *s* (which are to be considered as combined to form a three-pole switch) are opened; in consequence, no sparks can be formed at the switches, and no oscillations can be produced in the cables. In the same way dangerous oscillation in the cables will be prevented, if the switches, s_1, now be opened, because there are produced at these switches sparks, the extent of which depends upon the resistance, *r*. Such sparks, as is known, allow of no rapid oscillations, in contradistinction to the charging sparks produced on the switching in of unloaded cables. The loading resistance, therefore, acts as a damper of oscillations. The arrangement, which can, of course, be applied to networks having any number of phases, will be as follows: If the unloaded cables, *k*, are to be separated from the network, *n*, then, in the first instance, the switches, s_1, s_2, of the auxiliary are closed, one after the other; the switches, *s*, are then opened and the direct connection between the cables, *k*, and the network conductors, *n*, thereby broken; the switches, s_1, are then opened, whereby the cables, *k*, are deprived of their pressure and by finally opening the switches, s_2, the cables are separated from the auxiliary appliance. When connecting unloaded cables, *k*, to the network, *n*, the switches have to be manipulated in the reverse order, by first closing s_2, then s_1 and by finally closing *s*. When the cables are connected to the mains direct, the switches, s_1 and s_2, are opened one after the other and the auxiliary appliance thereby disconnected. The auxiliary appliance, described above, is also very suitable for testing cables under pressure. In this case the main switches, *s*, would be open or entirely dispensed with. If a higher pressure than that of the existing network pressure is to be used for the testing, then the translation ratio of the windings, w_1 and w_2 instead of being 1 to 1, is made to correspond with the intended testing pressure.

New Positive Clutch.—*The Engineer* of London describes the form of clutch shown by Fig. 2, which has been designed with a view to meeting conditions in which the ordinary friction clutch is not applicable, and where, on the other hand, the older claw-clutch is too violent in its action. The illustration shows the clutch applied to a V-grooved pulley, a longitudinal section through the shaft, a section on the line *X X* being given. The clutch is, of course, equally applicable to a flat pulley or a geared wheel. The construction is as follows: The pulley (or gear wheel), *A*, revolves loosely on the boss, *B*, which is keyed to the shaft of the machine to be driven, and forms the body or main part of the clutch proper. The part, *B*, is provided with pawls, *C*, which slide in slots, as shown. Revolving loosely also round *B* is the ring, *R*, which is provided with recesses, *E*, to receive the pawls, *C*. The ring, *R*, fits into a circular rebate on the pulley, *A*, and has, formed on it, two projecting portions, in which are the recesses, *E*. These projections also form the driving-arms of the clutch, by which the power is transferred to the pulley through the medium of the volute springs, *V*. It will be seen that these springs at their larger ends fit into recesses in the pulley, *A*, and therefore do not cause friction by rubbing on the clutch-ring. The outer extremities of the pawls are chamfered, and a slight additional recess, shown at *F*, is made in the clutch-ring. This recess not only assists the engagement of the clutch, and permits it to drive in either direction, but also enables either part to overrun the other, or run free, and materially assists the clutch to pick up its work. The pawls, *C*, are operated by the toggle-arms, *T*, and the sleeve, *J*; the latter sliding on a feather-key on the shaft. The sleeve is acted on by the collar, *K*, and the pawls are kept up to their work by the spring, *S*, which acts against the fixed collar, *M*, secured to the body of the clutch, *B*, while the pulley receiving the power is retained in place by the lock-nuts, *D*. A dust-cap, *H*, secured by screws tapped into the body of the clutch, is fitted as shown. This cap is preferably made in halves, and is recessed to fit a corresponding projection on *A*, thus excluding dust and dirt when working in exposed positions. A ball-bearing may be fitted to *A* if desired. One advantage claimed for the clutch is the absence of end-thrust when it is in operation. The clutch can also be laid bare for examination or repairs by simply removing the dust-cap, *H*. This clutch seems well adapted for light machinery.

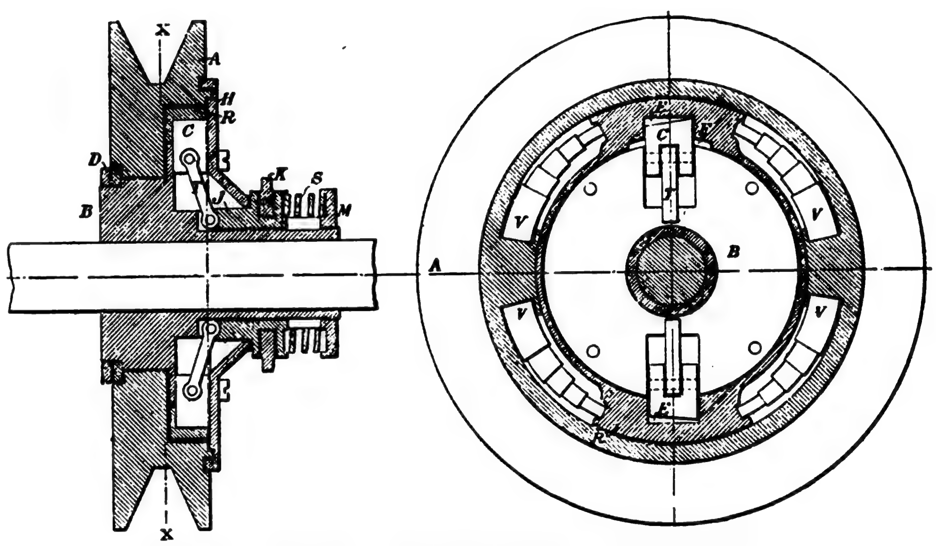


FIG. 2.—SECTIONAL SIDE AND END ELEVATION OF CLUTCH.

Steam Engine Research.—The first report of the Steam Engine Research Committee which was constituted at the instance of the late Mr. Bryan Donkin to investigate and carry out research upon the initial condensation in steam engine cylinders, was read by Prof. D. S. Capper before the British Institution of Mechanical Engineers recently. For the purposes of investigation a special engine was erected in the Engineering Laboratory at King's College. The engine was a horizontal compound engine, with cylinders 6½ ins. and 11¼ ins. in diameter by 14 ins. stroke. The cylinders are side by side, and the connecting rods drive cranks placed at right angles. Each cylinder is separately jacketed on the barrels and the ends, the supply and drain from the ends being separate from that for the barrel. Each cylinder is fitted with a Meyer expansion-valve adjustable by hand, so that the cut-off can be separately varied between one-quarter and five-eighths of the stroke. By grid valves on admission and exhaust sides, either cylinder can be arranged as a simple engine, and by blocking either of the Meyer plates the engine can be made single acting. In any of its varied adjustments the engine is as nearly as possible an ordinary commercial engine, clearance volumes and contact surfaces being kept as small as possible. The clearance volumes for the high-pressure cylinder are 0.025 cu. ft. at the front and 0.033 at the back; and for the low-pressure cylinder 0.053 cu. ft. at the front and 0.056 at the back. On the trials the low-pressure cylinder was not in use, the engine being run as a single-cylinder engine exhausting into a condenser, with the vacuum reduced to

2 in. to 3 in. of mercury. In this way the back pressure in the cylinder was kept constantly at atmospheric pressure. The volume swept through by the high-pressure piston is 0.269 cu. ft. at the back end and 0.254 at the front, after deducting the volume of the 1½-in. diameter piston rod. The clearance space is therefore 12.4 per cent. of the cylinder volume at the back and 9.8 per cent. at the front end. The flywheel is 5 ft. in diameter and water cooled. To ensure steady running at slow speeds, a second flywheel, 7 ft. in diameter, was provided and fitted in halves, so that at speeds above 100 revolutions it could be readily removed. But after the preliminary trials the larger flywheel was found unnecessary and was removed, as, within the range of speeds required, the engine ran perfectly steady without it.

The committee decided that the first series of trials should be made with the engine arranged as a single-cylinder, high-pressure engine, non-condensing jacketed, the second series being a repetition of the first series, but without jackets. After a careful study of previous experiments it was further determined that the variables should be temperature and speed, cut-off and all other conditions being kept constant. Temperatures of 245° F., 280° F., 315° F. and 350° F. were chosen, so as to give equal intervals between successive trials of the series. These temperatures correspond to about 27 lb., 49 lb., 84 lb. and 135 lb. per square inch absolute, respectively, at the engine steam chest. The chosen speeds were 50, 100, 150, 200 and 250 r.p.m., corresponding to piston speeds of about 117 ft., 334 ft., 350 ft., 467 ft. and 584 ft. per minute, respectively. For reasons given below it was not found possible to adhere absolutely to these speeds and temperatures.

A large number of preliminary trials were made to determine the best cut-off, exact speeds and temperatures which could be accomplished with the plant, and to find the best methods of adjusting and working the measuring apparatus, etc. It was found that it was impossible to extend the range of speeds to the lowest limit of the engine—namely, 25 r.p.m.—without interfering with the upper limit, and it was likewise found that at the lowest temperature and pressure the auxiliary pumps could not be got to work. At the upper limit of pressure and lower limit of speed, and at the lower limit of pressure and upper limit of speed, trouble was found in keeping the conditions quite steady. After numerous attempts it was finally found necessary to work the boiler at a slightly higher pressure than that actually required, and to get the exact and steady temperature in the steam chest by slight throttling at the engine stop valve.

At the lowest temperature of the series, and in one or two other cases, this throttling was sufficient to cause superheating. The cut-off which was required to obtain the largest range was found to be three-eighths of the stroke, and this was adhered to throughout both series.

It is dangerous to draw conclusions of too general and sweeping a character from experiments upon one type of engine under one set of conditions, but it may fairly be claimed that the ground covered by this report has never previously been surveyed with an engine showing more consistent and definite results, nor under conditions which enabled so detailed an analysis of the results to be made. The points which have been elucidated may be summarized as follows:

First, leakage through the slide valve has been quantitatively determined under defined conditions, and has been shown to be nearly independent of speed of sliding surface and proportional to difference of pressure between the two sides of the valve. Further, it has been shown that the assumption that the leakage is inversely as the overlap of the valve is at least in the main well founded. And, further, that with well-fitted valves the leakage may amount to over 20 per cent. of the steam entering the cylinder and is rarely less than 4 per cent.

Second, it has been shown that for an unjacketed engine with a given ratio of expansion initial condensation, expressed as a percentage of the steam in the cylinder, *diminishes* with increase of initial temperature, while the total condensation per stroke *increases* with such temperature increase. This, though suggested, had never previously been demonstrated with clearness, as if leakage is not allowed for, the results are obscured and even reversed, and the conclusions arrived at without leakage allowance are therefore unreliable.

Third, it appears from the results here obtained that the re-evaporation for a given ratio of expansion is as great and sometimes greater without jackets than with them. This shows very clearly that the regenerative action of the cylinder walls with a given ratio of expansion is largely independent of their mean temperature. No quantitative analysis of re-evaporation is possible where leakage is not taken into account, as without the necessary allowance results would be largely illusory.

Fourth, it is possible from the results obtained to show the temperature when for any speed of revolution with a given rate of expansion the jackets will become unnecessary or wasteful. If the heat units per indicated horse-power per minute required by the unjacketed engine for each speed of the series be plotted either on an initial pressure or a mean effective pressure base the points for each speed will be found to lie on four curves, which become closer and closer to one another as the speed increases, and all converge to a point as pressure or temperature increases. If the heat consumption for the jacketed series be likewise plotted, it will be found that the points for the different speeds at each pressure lie irregularly round a point, their exact position being determined by the accidentally slight variations of the conditions of each trial.

A fair curve through the means of these points will lie below the corresponding curves for the unjacketed trials, but if the heat absorbed in the jackets be included the resultant curve cuts the unjacketed curves at points which for each speed indicate the temperature and pressure at which the jackets cease to be economical. Such curves are shown on Figs. 3 and 4. It will be seen that the full black line, which is the resultant mean for the jacketed trials, cuts both the 250 and the 200-revolution unjacketed curves within the temperatures and pressures included within the scope of the present experiments, and the temperatures and pressures where the 150, 100, and even the 50-revolution curves would cut, can very closely be predicted. This is the first time that an exact determination for a given engine and ratio of expansion of this point has been diagrammatically shown.

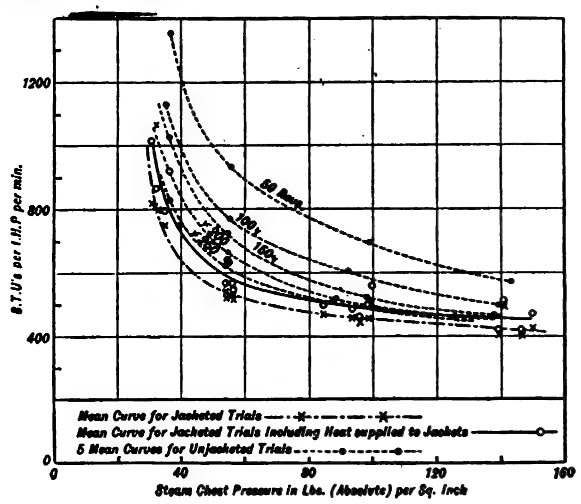


FIG. 3.

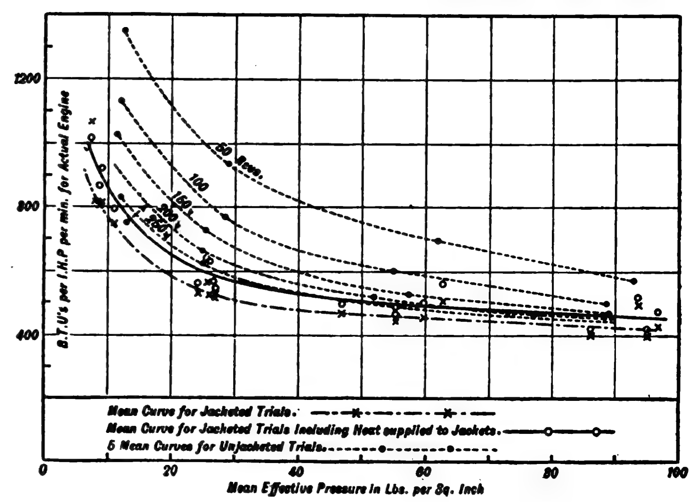


FIG. 4.

Diesel Oil Engine.—*The Engineer,* of London, describes a British-built Diesel oil engine made by the Mirrlees-Watson Company, of Glasgow. The company met with many difficulties in its first engine, which was in some respects a failure; but after waiting a number of years material progress had been made, and it constructed another. In this case the size selected was 35 brake horse-power, single cylinder—the diameter of the cylinder being 11¾ in., stroke 18 in., speed 190 r.p.m. This engine, which embodied the various improvements which had been made up to that time, was started in the early part of 1903, and was put through a series of brake tests and reliability trials, which it passed successfully, and it was decided to install it as part of the works plant and treat it in every way as an ordinary engine. It was therefore arranged that the engine should drive a load of a very variable character, such as wood-working machinery, cranes, etc., this being the character of load which would try it most severely. One of the changes embodied in this engine was in connection with the air compressor. The first engine made gave trouble owing to the high temperature of the air in the air compressor; to overcome this the German company compressed the air in two stages in a very ingenious manner, advantage being taken of the fact that air only is compressed in the main cylinder during the compression stroke. It was arranged to draw from the main cylinder air compressed to about 150 lb. pressure. For this purpose the overflow valve was placed in the cylinder cover, and opened momentarily during the compression stroke, when the compression in the cylinder was about that named. The air passed out of the cylinder to a cooler, and from there was delivered to an air pump of small diameter. By this arrangement the main cylinder and the small pump formed a two-stage compressor, with an inter-cooler between the stages. This got over the trouble experienced with the compressor valves when using a single-stage compressor, as in the engine constructed in 1897, and it worked admirably when using clean oils, such as are readily obtainable in Germany. The company, however, was anxious that the engine should be entirely suitable for using crude fuel oil, such as Texas crude petroleum. After some months of regular working with crude oil, it was found that a brown deposit formed on the air-compressor valves. Experiments were, therefore, carried out to discover the cause of this deposit, and it was found that although the combustion was perfect, and the exhaust practically colorless and odorless, a fine brown dust, persumably the ash of the heavier constituents of the fuel oil, was deposited in the combustion chamber; a little of this became mingled with the air passed to the air compressor. The amount of this dust was extremely slight per stroke, but became, after a few months of working, appreciable and sufficient to affect the tightness of the compressor valves, unless these were cleaned regularly. To obviate this frequent cleaning of valves—the only

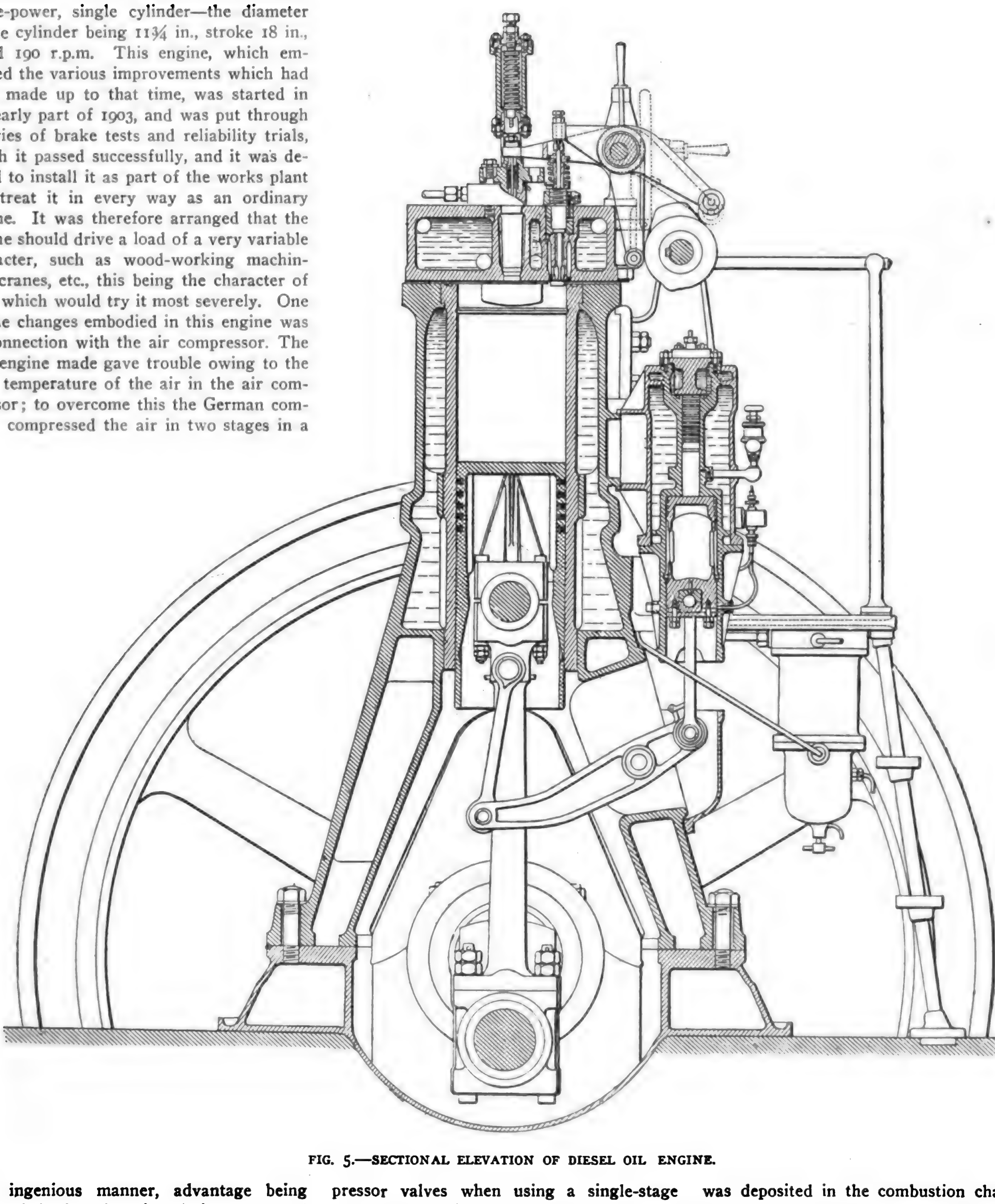


FIG. 5.—SECTIONAL ELEVATION OF DIESEL OIL ENGINE.

difficulty in the engine—an entirely independent two-stage air compressor fitted with efficient cooling arrangements was

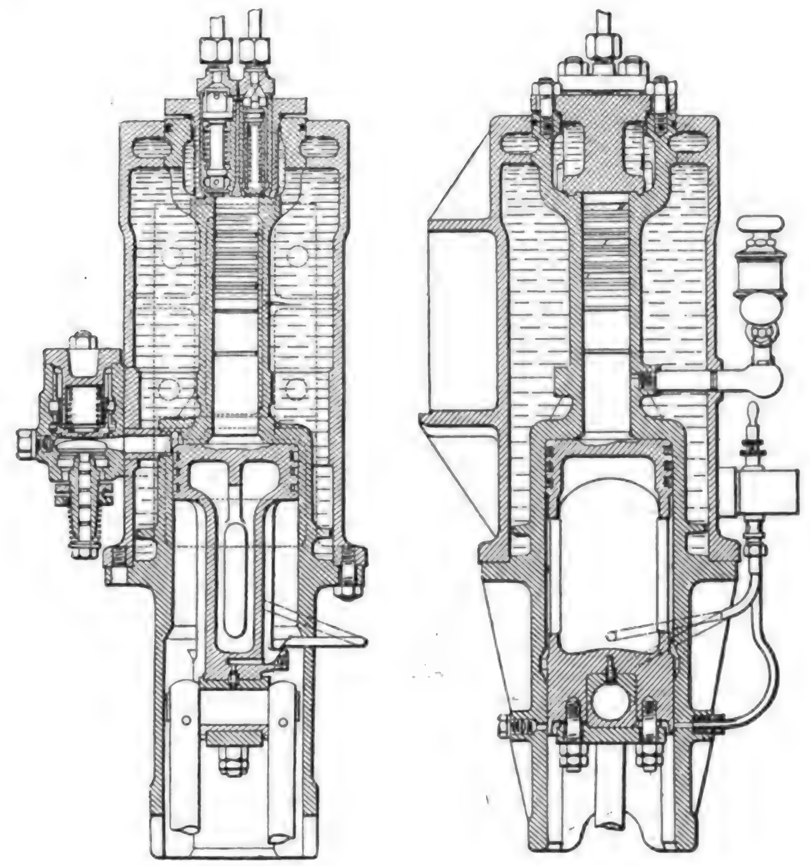


FIG. 6.—SECTIONAL VIEWS OF TWO-STAGE COMPRESSOR.

constructed. Air was supplied from this compressor, and it was found that by this means the difficulty just described was overcome. A second engine was then made and fitted with a two-stage compressor compactly arranged on the frame of the engine, as shown by Fig. 6, in which the two-stage compressor is shown to a larger scale, and in designing which great attention was given to the valves and to the cooling arrangements.

Overhead Transmission Lines.—The London *Electrician* contains M. Semenza's paper, read before the Italian Electrical Society on "Overhead Transmission Lines," in which the author deals especially with the construction of the poles. The author recommends iron posts and describes what he considers a very great improvement in the construction of metallic supports, consisting in making them elastic. In a straight track, and with equal spans, the only force acting on the supports, apart from the weight of the wire, is the transverse wind pressure. It is, therefore, unnecessary to make them withstand a longitudinal stress, and they need only be designed for a transverse stress. As is seen from Fig. 7, they consist of two parallel uprights of channel iron about 2 meters apart trussed together with angle irons. Should the wires ever get broken, the supports by their elasticity will bend in the longitudinal direction, and this deflection will instantly diminish the tension. In the highly improbable case of the breakage of all the wires in one span, it is found that the first support beyond the break will deflect considerably, but as this deflection diminishes the length of each successive span, and, therefore, the tension of the wires, the second support will be deflected, but to a less extent. The farther

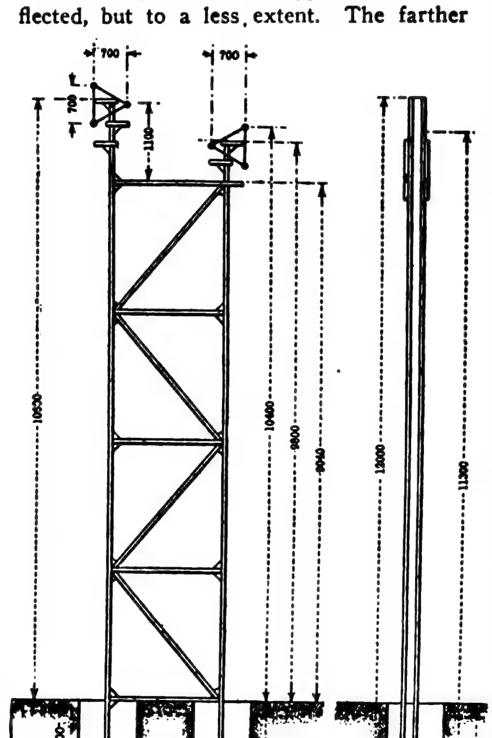


FIG. 7.—STRUCTURE FOR TRANSMISSION LINES.

supports will also deflect, but will always to a lesser degree, and by calculation it is found that should the tension be entirely removed from one side the resulting stress would not exceed half that on a rigid support. Thus he arrives at "the apparent paradox that the weakness of the support is a factor of its resistance to breaking." The author urges the great importance of the choice of proper insulators.

Economical Supply of Light Load.—There are quite a number of small and medium-sized central stations which supply a lighting and traction load, and these require besides the battery for the traction system, an additional battery for the lighting system after midnight, especially if the load is so light that the operation of a generator would be uneconomical. Where the lighting supply is alternating a small machine must be kept running to supply this load. B. Jacobi describes, in a recent number of the *Elektrotechnische Zeitschrift*, an arrangement which has been in operation for a number of years and proved satisfactory and economical. This is shown diagrammatically by Fig. 8 herewith. The station supplies high-tension, three-phase current for light and power and 500-volt direct current for the railway system. This latter current is supplied from the rotary, *R*, which is supplied from the generator, *G*, through the transformer, *T*. After midnight, or when the railway system shuts down, the traction battery, *P*, supplies the lighting load. In the diagram, *Z* represents a booster, *A* a starter, *N* a shunt regulator, *V* a voltmeter, *SV* a synchronizing voltmeter, *MT* a switchboard transformer, and *Sp* the supply network. During the day *R* runs in parallel with *P* and supplies the traction current. *Z*, which is directly coupled with *R*, runs unloaded; *EA* is open and *ZU* is in its middle position; *EU* is closed upwards in the diagram and connects the positive pole of the battery with the bus-bar. For charging, while *R* is still running, *A* is short-circuited, *EU* is thrown to the downward position in the diagram, and *ZU* is closed upward. After adjusting the correct booster voltage by means of N_2, *EA* is closed and the charging begins. The voltage of *Z* is added in the usual way to that of *R* and is properly adjusted by means of N_2 until the charging is finished. After setting *R* and *Z* at rest it is intended to let *R* supply the lighting current for the night hours. All switches are open, as is also *A*. Now *EU* and *ZU* are connected downward. By means of N_1 strong excitation of *R* is produced, and by means of N_2 medium excitation of *Z*. Then *EA* is closed and by means of *A* the set *RZ* is slowly started with current from *P*. As soon as *A* is short-circuited, DA_2 is closed, VU_2 is connected to MT_1 and at V_2 the voltage at the high-tension terminals of *T* is read. By means of N_2 adjustment is made until V_2 shows the correct supply voltage. It is still necessary to connect *R* in parallel with the running machine, *G*. For this purpose N_1 is used. Since *R*, operated as a direct-current motor from P_1, behaves like a shunt motor, a change of the field produces a variation of speed. When *SV* shows synchronism, *DA* is closed and *G* is finally brought to rest and disconnected. The lighting current is now supplied from *P*. It will be seen that by means

of ZU the polarity of Z has been reversed; that is, the negative pole of Z is connected with the positive pole of P. By this means the decrease of the battery e.m.f. during discharge can be counteracted by Z, so that at the terminals of R and T the voltage is held constant.[1] In actual operation it is found that although P discharges, the voltage at the high-tension terminals of T is automatically maintained constant. The explanation is that R and Z are excited from the battery so that when the voltage of P decreases, the excitation of R is decreased and the speed of R increases so that the e.m.f. furnished by Z also increases, although its field is weakened. Thus the voltage at the terminals of R remains approximately constant, while the speed and frequency increase. Should the frequency become 10 per cent higher than the normal value, it is necessary only to adjust N_1 and N_2 so as to increase both currents, whereby the speed of R is reduced, while the voltage of Z which is thereby diminished, is again raised. This adjustment may be made once an hour.

Some Recent Electrical Patents

Armature Winding and Commutators for Alternating-Current Motors.—In order to avoid the trouble due to the currents induced by the alternating flux in the armature coils short-circuited by the brushes of a commutator-type, alternating-current motor, Mr. Max Deri, of Vienna, Austria, proposes to equip the armature with two distinct windings intermeshed mechanically around the core, of course, and two distinct sets of commutator bars and brushes. The brushes are made too thin to touch two commutator bars simultaneously, so that when a brush leaves a bar it opens the circuit of the corresponding winding. The brushes are arranged so that when one winding is thus open-circuited the other is in connection with its brushes, so that the armature as a whole is never open-circuited by the brushes—the armature activity is merely shifted from one winding to the other. The diagrams, Fig. 1, illustrate this arrangement as applied to a repulsion motor, but the inventor states that it is equally applicable to a series motor or to one in which the armature takes current from a constant-potential source. Patent No. 786,010.

Arc Lamp.—In most arc lamps, both shunt wound and differentially-wound, the shunt magnet coil remains connected to the lamp terminals under all conditions, so that when the lamp becomes extinguished accidentally or by any means other than the manipulation of the cut-off switch, the shunt coil remains in the main circuit. The objections to this are obvious, although not usually very serious. In order to eliminate the disadvantage entirely, the mechanism shown in Fig. 2 has been devised by Mr. Bruno Jackisch, of Charlottenburg, Germany. The engraving illustrates diagrammatically a differential lamp, the shunt coil being at *n* and the series coil at *h*. The solenoid plunger, *s*, is hollow and carries with it in its movements the carbon sheath, to the lower end of which is attached the clutch member. The plunger carries at its lower end a vertical extension, *f*, to which one terminal of the shunt magnet coil is connected. Under normal operating conditions this extension finger is in contact (at *a*) with the lower end of a slider, *c*, which is connected to the negative terminal of the lamp and therefore completes the

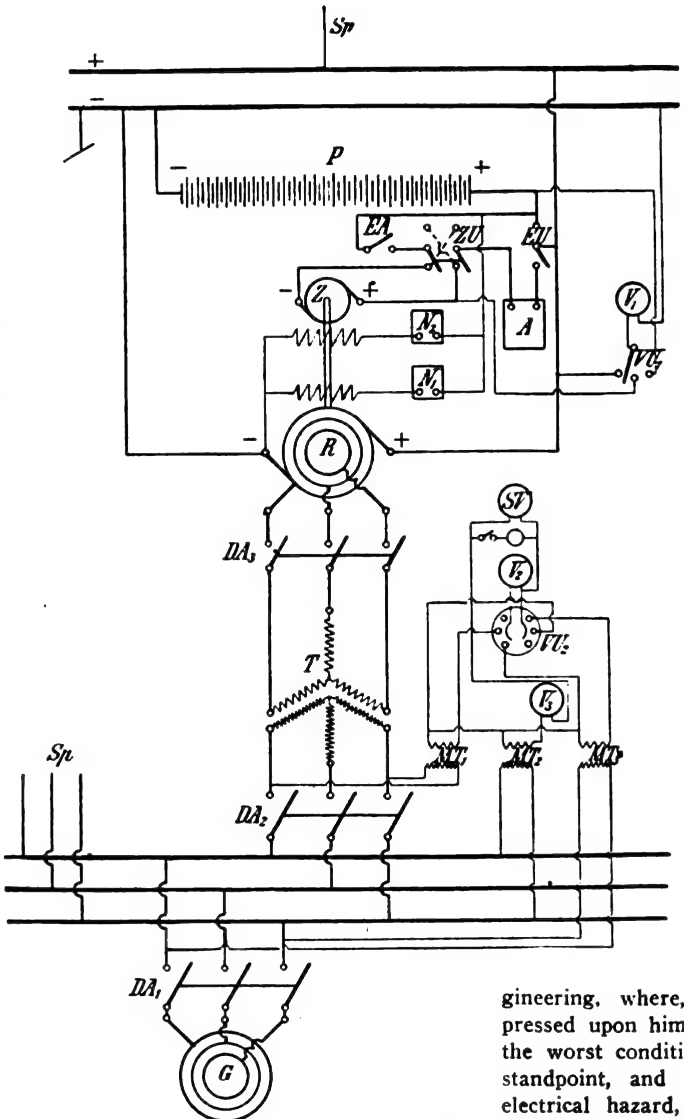


FIG. 8.—ECONOMICAL SUPPLY OF LIGHT LOAD.

circuit of the shunt coil. The slider follows the movements of the plunger within the full operating range, but if the plunger drops far enough to release the carbon entirely, as it does when the arc is extinguished, the head of the slider, *c*, will rest on the mount, *d*, before the plunger reaches its bottom limit of travel, and the finger, *f*, then moves away from the slider and opens the circuit of the shunt magnet coil. This, therefore, is the normal condition whenever the arc is extinguished from any cause whatever. Of course, when the series coil picks up the carbon in starting the lamp, the shunt circuit is closed at *a* before the full length of arc is established. The inventor does not state how this arrangement is to be applied to a simple shunt-wound lamp. Patent No. 787,043.

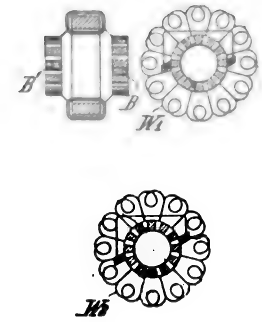


FIG. 1.

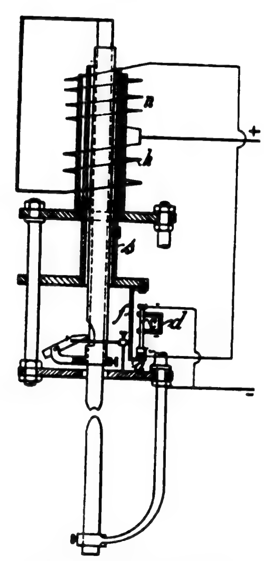


FIG. 2.—ARC LAMP.

Fire Risks in Isolated Plants.

To the Editor, American Electrician:

SIR:—The initial sentence of your editorial in the February number on "Fire Risks in Isolated Plants," has struck a responsive chord in the writer, whose business, while in no way connected with fire insurance or the underwriter's board, takes him through many power houses and related properties, both large and small, in relation to questions of fire protection engineering, where, the fact has been impressed upon him that, generally speaking, the worst condition of affairs from a fire standpoint, and especially regarding the electrical hazard, exists in power houses, car barns and electric plants, where it would naturally be assumed that the most attention would be given these features.

The portion of your editorial calling attention to the simple yet highly desirable protective devices which should exist in all such properties is admirable, bearing in mind that sand is most adapted to quenching oil and electric fires, water-pails to more combustible materials, such as exist in the stockroom, extinguishers are most appropriate in locations where it may be necessary to reach a fire not readily accessible with fire pails, such as among the roof structure or where the flames may quickly spread over a considerable area upon which a pail full of water would produce only momentary effect. Of course, chemical extinguishers are desirable in almost all locations, except where exposed to freezing, although their cost may sometimes mitigate

against their being provided among rougher classes of work, or where water pails will probably be satisfactory.

The more important features in fire protective engineering, however, are the defectively arranged and too often inoperative condition of the fire lines, hose and pumps. There seems to be no limitations to the foolish methods and carelessness shown in the installation and maintenance of fire lines and hose equipments. The engineer of an electric plant usually assures the writer that everything relating to the fire protective devices is in perfect order, but an examination or test shows them (it may almost be said in the majority of cases) to be at least wholly inadequate or inoperative, when viewed from a practical viewpoint of the operating requirements. This may be a somewhat broad statement, but the writer, although for many years connected with electrical and civil engineering, has been continually surprised since turning his attention to fire protective matters at the woeful lack of appreciation of the common hazards, and especially those due to electricity, existing among the average industrial and electrical plants throughout the East. The larger question of building design from a fire standpoint should also receive more attention from engineers. A station is not made fireproof merely by the presence of a concrete floor and brick walls, when the roof is of plank on light steel trusses. It is astonishing with what fierceness the insulation on a few ordinary type cables will burn, and what damage can be wrought in a steel roof structure by a fire among a small amount of combustible material. The roofs of many all-steel fireproof car barns have been practically destroyed by the burning of perhaps a portion of one car or some wooden lockers or oil cabinets in the barn. It is, of course, well known that there are monumental and striking examples of the highest development of the art of protection against fire, both regarding proper building construction and adequate protective devices, in many of our large urban electric stations, or in the suburban sub-stations thereof, but in speaking as a whole the electric stations can hardly be said to be even up to the average from a fire standpoint. This may be due to the hurried development of electrical industries and the great amount of work which has been done by engineers with relatively little available capital in many cases, but it is to be hoped that now that electrical enterprises are being promoted upon a conservative and substantial financial basis, that plants will be built or rebuilt upon broader principles and with the proper concern for permanency and stability which can be secured only by careful attention and conformity to the principles of fire protective engineering.

R. A. Whittick.

Philadelphia, Pa., April 12, 1905.

CENTRAL STATION ENGINEERS.

VII.

John A. Britton.

John A. Britton, general manager of the California Gas & Electric Corporation, was born October 9, 1855, in Boston, Mass. When he was 13 years old his parents migrated to San Francisco, Cal. Here he received such education as the public schools afforded and afterward devoted two years to the study of law. His exceptionally active career in the field of public lighting was begun at the early age of 19, when he entered the employ of the gas company in Oakland, Cal. His aptitude for business soon met with the approval of his superiors, for nine years afterward found him secretary of the company. In 1894 he became the company's engineer, and held this post for several years, when he was singled out for further distinction, and in 1900 he was

JOHN A. BRITTON.

elected to the presidency of the company. He also acted as consulting engineer for the Stockton Gas Company, Power Transit & Light Company, and the California Central Gas & Electric Company. Mr. Britton installed the first electric lighting plant in Oakland. This was put in operation in 1882, the capacity being 125 horse-power. The present capacity of the plant is 4000 horse-power. Since 1892, with the exception of the years 1901 to 1903, Mr. Britton was secretary of the Pacific Coast Gas Association, and is at present a member of the Board of Regents of the University of California. As previously stated, Mr. Britton is the general manager of the California Gas & Electric Corporation. This company controls the Sacramento Electric, Gas & Railway Company, the California Central Gas & Electric Company, the Bay Counties Power Company, the Valley Counties Power Company, the Oakland Gas, Light & Heat Company, the Fresno Gas & Electric Light Company, Standard Electric Company of California and its subsidiary companies, the United Gas & Electric Company, the South Yuba Water Company and the Central California Electric Company. The company owns the entire street railway system of Sacramento, Cal., and owns and controls all of the electric light and power transmission lines, gas plants and water rights in Sacramento and vicinity.

NOTES.

Electricity in a New Grocery.—Although the details of the grocery business fall considerably outside the electrical engineer's usual activities, a recent installation in Worcester, Mass., deserves attention in view of its lavish use of electric lighting. The establishment is that of the Central Grocery Company, opened very recently. The store consists of a large salesroom on the street floor, a reception room at one end for the use of customers, a general office and private offices. There are also shipping and storage rooms close at hand. The striking feature however, is the use of "Meridian" lamps in clusters of five in the main store. These are of the 120-watt type and they are covered by frosted shades. In the main store, which consists of a room about 75 feet long by 25 feet wide, and a bay 20 feet by 35 feet, approximately, are no less than 90 "Meridian" lamps, while over the doorway is a cluster of five more, with a cluster of the same number in each of the two show windows. The reception room contains a cluster which partly illuminates the main store, and there are two single lamps in the private offices. The total number of such lamps is 112, according to a hasty visit made soon after the store opened. In various places 16-c.p. incandescents are also employed for lighting desks, etc. The resulting illumination is soft and very brilliant, and as an advertisement of a new establishment it is exceedingly effective. At the same time it would seem that the use of clear globes would have been better practice, for the lighting could then have been done with 40 or 50 per cent of the present equipment, and quite as effectively. The grouping of globes would give the even illumination required, and the suspension of the lighting units near the ceiling obviates any difficulty in regard to the eyes of customers. From the engineering standpoint the illumination is admirable in the whole, but inefficient in the details. The contractor for the installation apparently carried the idea of translucent globe effects too far. Two 500-volt motors are in use in the store. One is a ½-h.p. Holtzer-Cabot machine driving the cash carrier system; the other is a 2-h.p. Westinghouse motor direct-connected to a coffee mill.

Summer School for Artisans.—The University of Wisconsin, Madison, Wis., announces the opening of the fifth session of its annual Summer School for Artisans on June 26. The school closes on August 4. The courses cover the following subjects: "Engines and Boilers," "Applied Electricity," "Mechanical Drawing and Machine Design," "Materials of Construction, Fuels and Lubricants" and shop work.

Electric Lighting Costs in Massachusetts.—A writer in a New England paper states that an examination of the reports of the Massachusetts Board of Gas and Electric Light Commissioners for the five years ending with 1903 developed the fact that the cost of electric lighting in municipal plants during that period increased in two-thirds of the cases, while in a total of 63 cases of lighting by private plants, only seven had increased their prices and the remaining fifty-six showed a decrease.

The Southern Supply and Machinery Dealers' Association held a conspicuously successful convention April 25 to 28, inclusive, at Savannah, Ga. The delegates discussed freely a number of practical and important topics, and enjoyed more than the usual offering of entertainment features. The active membership now includes dealers in Alabama, Arkansas, Florida, Maryland, Missouri, North Carolina, South Carolina, Tennessee, Texas, Virginia and West Virginia, and the list of honorary members contains the names of manufacturers all over the country.

An Induction Motor in a Direct-Current Plant.—An interesting application of an induction motor in a plant equipped with direct-current apparatus occurs at the East Moline shops of the Chicago, Rock Island & Pacific Railway. The main generating equipment of the power house comprises 250-volt, direct-current dynamos, which supply current to the motor-driven tools throughout the establishment. The pumping station, however, is about two miles away on the banks of the Mississippi River, and the pumping machinery is driven by a 50-h.p., three-phase, 220-volt induction motor. Current for this motor is supplied from a line fed by an inverted rotary converter. Thus by the use of this type of motor the advantages of a higher voltage are realized, besides the low cost of maintenance characteristic of induction machines.

Stevens Institute Affairs.—The authorities of Stevens Institute of Technology have taken up vigorously the task of raising the additional $100,000 required to render available the $100,000 conditionally donated by Mr. Andrew Carnegie and President Humphreys ($50,000 each) at the recent dinner of the Stevens alumni. It is expected that the alumni will heartily cooperate by contributing and also by awakening the interest of their friends. Through the generosity of the Stevens family, the Institute has been enabled to secure for athletic grounds, campus and building purposes that part of the historic "Castle Point" estate at Hoboken most advantageous for such uses. In the near future this land will be graded and properly laid out, if the hopes of the Institute management are realized.

Reduction in New York Telephone Rates.—The New York Telephone Company announces a very comprehensive revision of its rates to take effect May 1. The principal changes in the schedules are shown by the following tables:

RESIDENCE SERVICE:

Number of Messages.	Direct line. Old rate.	Direct line. New rate.	Party line. Old rate.	Party line. New rate.
600	$66	$54	$54	$45
800	78	63	66	54
1000	90	72	78	63
1200	102	81	90	72
1800	138	105		
2400	165	129		

BUSINESS PARTY LINES:

Messages.	Old rate.	New rate.
800	$75	$69
1000	87	78
1200	99	87
1500	117	99
1800	135	111
2100	153	123

The toll rates have also been revised, but the new rates go into effect June 1 instead of May 1. They are as follows:

	From Manhattan.		From Bronx.	
	Subscriber's rate.	Pay station rate.	Subscriber's rate.	Pay station rate.
Astoria	$.10	$.15	$.15	$.20
Bath Beach	.15	.20	.20	.25
Bronx	.10	.15	—	—
Brooklyn	.10	.15	.15	.20
Coney Island	.15	.20	.20	.25
Far Rockaway	.20	.25	.20	.25
Flushing	.15	.20	.15	.20
Jamaica	.15	.20	.15	.20
Manhattan	—	—	.10	.15
New Dorp	.15	.20	.20	.25
Newtown	.10	.15	.15	.20
Tompkinsville	.15	.20	.20	.25
Tottenville	.20	.25	.20	.25

International Prize Competition.—An international competition for prizes for various appliances has been announced by the Association of Italian Manufacturers, the list of appliances and prizes being as follows:

A.—A gold medal and 8000 lire for a new appliance for preventing accidents arising from contacts between primary and secondary windings in alternate-current transformers. The appliance must fulfill the condition that no disturbance in the action of the transformer must arise in case of atmospheric discharges or abnormal increase of potential.

B.—A gold medal and 1000 lire for a novel system of hand crane or winch fitted with a simple and practical contrivance to prevent the possibility of the handles revolving during the descent of the load.

C.—A gold medal and 500 lire for a safety appliance to be simple, strong and reliable, to stop trucks automatically on an inclined plane on the hauling rope snapping. The appliance must be adaptable to existing plant.

D.—A gold medal for a system of absorption and collection of the dust produced in sorting and cutting rags by hand without giving rise to draughts detrimental to the health of the workpeople.

E.—A gold medal for a system to carry off by suction the dust generated by carding flax, hemp and jute without detriment to the neighborhood.

F.—A gold medal for a system to prevent the diffusion of dust in lime and cement works.

The conditions of the competition are as follows:

1.—Applications to compete must be sent in not later than July 31, 1905, addressed to the president of the Association of Italian Manufacturers for the Prevention of Accidents in Factories, Foro Bonaparte, 61, Milan.

2.—All appliances entered for competition for the prizes *A, B, C* must be exhibited at the competitor's expense, in such dimensions and conditions as to allow of their being practically tested at the Milan Exhibition of 1906 in such time as may be determined by the Exhibition Committee.

3.—No charge for space will be made to competitors who intend to exhibit their appliances in the space allotted to the association; they must, however, in their applications to compete, state the exact area they require. The acceptance of all applications to compete is optional with the president of the association.

4.—Competitors who elect to exhibit in other sections of the exhibition must allow a notice to be attached to their appliances stating that they form part of the competition founded by the association. They must forward to the association not later than January 1, 1906, a properly executed, detailed drawing of their appliances, which the association will exhibit in its own section.

5.—Competitors for the prizes *D, E* and *F* must have their appliances at work in works in Italy; they must also forward to the association, to be placed in its exhibit, a detailed drawing, a small model and a full description of their appliances.

6.—All appliances presented for competition are the property of competitors; the association will, however, retain the drawings, models and descriptions. All rights connected with the appliances are the exclusive property of their owners, who must, however, take all necessary steps to guarantee their rights.

7.—The association reserves the right to publish, at the close of the exhibition, descriptions and drawings of all the appliances.

8.—A committee appointed by the council of the association will examine all appliances presented for competition. The appliances approved of on principle will be subjected to tests, after which they will be classified according to their merits. The council of the association will award the prizes in accordance with the report of the committee; no appeal from their decisions will be entertained.

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CONTENTS.

Back Numbers.

Until recently the publishers of this journal have endeavored to keep in stock indefinitely a supply of back numbers, but experience has demonstrated that the trouble involved in keeping separate numbers more than a year old is out of all proportion to the value of the accommodation to subscribers. It has been decided, therefore, to keep separate copies for only twelve months back. Readers desiring copies dating farther back than May, 1904, should order them immediately, as the stock on hand will be disposed of as quickly as possible. Bound volumes will be kept in stock as usual.

Improving the Load Factor of a Central Station.

The operation of an electric power station at or near its rated capacity is recognized as being one of the most important considerations in station economics, and it is particularly advantageous, therefore, to study the load factor under varying conditions of service. Depending on the kind of work performed, the ratio of the average load to the aggregate rating of the machinery differs widely in different cases, but in practically all plants high operating efficiency and the minimizing of unproductive charges require that the equipment shall be well loaded throughout the day's run. With a view to securing this result, station managers are turning their attention more and more toward the increasing of their motor loads and their outputs for advertising purposes, and many of them have made a careful analysis of the hours of operation of different parts of their plants with regard to the demand on those parts respectively.

Having fewer generating units, the small central station cannot be expected to follow the variations in its load as efficiently as a large, or moderately large, station does by varying the number of active units. In many cases, therefore, there is strong temptation to assume that it is not worth while to make any study of the load factor, there being possibly not more than two or three units in the station. There are, however, other factors in the improvement of the load factor besides the mere cutting in and out of generating units. It will usually be found advantageous, for example, where there are only required, say, 500 kilowatts maximum output ability, to install two good-sized units of equal capacity and a smaller unit for taking the minimum load. The relation between this small unit and the other two will depend considerably on the character of the service; in many cases one 100-kw. and two 200-kw. units would be found sufficiently flexible, while in others it might be advisable to use even a 50-kw. unit and to divide the remainder of the output equally between two larger units. This would be a rather extreme case, however. Again, the relative economy of the prime mover at full and partial loads should be carefully considered. It is sometimes better to sacrifice full-load efficiency in order to gain in the partial load performance of an engine; in fact, this is very frequently true in the case of a small central station.

Although the load factor of a station is ordinarily determined by plotting load curves and averaging the results, the easiest method, and one which is quite as satisfactory, is to compare the daily records of a recording watt-hour meter with the capacity of the generator in circuit with which it is connected. Such a meter integrates fluctuations much more accurately than voltmeter and ammeter readings can be plotted under ordinary operating conditions in small stations. It is, of course, necessary to keep an eye on the generator ammeter in order to see that no undue overloads are put on the machine. The load factor should be determined at reasonably short intervals throughout the year. The remedy for a poor load factor will depend entirely on the operating conditions in each case. No general rule is of any value.

Coal Handling in Isolated Plants.

A surprising proportion of the American isolated plants suffer great inconvenience in the matter of coal handling. In many modern buildings even, the location of the power equipment receives only cursory attention from the architect, almost any dark and otherwise useless corner of the subbasement being considered good enough to contain the expensive machinery on which the commercial success of the building depends to a very great extent. In some cases, a handsome engine and generator room is provided, but the boiler plant is stowed away in the darkness, with the coal pile situated beneath the sidewalk at a most inconvenient distance from the firing floor. All such arrangements mean increased operating costs, of course.

In a city isolated plant, such as that in a large hotel or office building, it would seem to be a relatively simple matter to provide for the economical handling of the coal, excepting the few cases in which it is really impracticable to allot a liberal space, even in the sub-basement, to the steam equip-

ment. It is obviously more expensive to deliver coal to an isolated plant than to a central station, owing to the unfavorable location of the former and the relatively small quantity of coal that can be stored, but once the coal is on the ground it should be practicable to dump it by gravity into a bin fairly near the boiler room and situated on a higher level so that it may be drawn through a chute into a barrow or small car in which it may be wheeled to the scales and thence to the firing floor; the resulting economy in time and manual effort would be profitable. The reshoveling of coal should be avoided just as far as possible; a small car running on an inclined track, or a power-operated hoist, or even a simple hand chain hoist, is well worth consideration wherever the cost of firing would otherwise be chargeable largely to the labor of moving coal from the storage bin to the firing floor. This also applies to the removal of ashes.

The Critical Freqdency for Alternating-Current Lighting.

It is undoubtedly the common impression that incandescent lighting at alternating-current frequencies below something like 35 cycles is not practical; in fact, one well-known authority on artificial illumination has stated that in general a 16-c.p. lamp of 100 to 120 volts begins to show the variations of current intensity at 30 cycles or a trifle above, and that at 25 cycles the fluctuations are very troublesome to most eyes. Only two of a considerable number of engineers with whom we have discussed the question expressed any doubt whatever that 25-cycle lighting is impracticable indoors. A little persistent inquiry, however, discloses the fact that the notion as to the uncomfortable effect on the eyes at 25 cycles is based on either hearsay cr a vague impression of having read some account of tests which showed that result. We have been unable thus far to learn of any thorough, impartial test made to determine the downward limit in frequency for incandescent lighting. The station lamps of the Manhattan Elevated Railway are supplied with 25-cycle current, but that is not much of a criterion for the reason that most of the lamps are out of doors, and those that are inside are not used in a class of service that would serve as a standard for general practice. The Buffalo General Electric Company is supplying incandescent lighting from 25-cycle circuits, but reports only "indifferent success." In view of the enormous investment already laid out in 25-cycle generating stations and the expense of putting in frequency changers for incandescent service from such stations, it would seem to be about time for somebody to make a few careful tests to determine once for all whether or not it would be safe for a central station to depend solely on 25-cycle current for incandescent lighting.

Arc lamps, of course, cannot be operated on any such frequency as 25 or 30 cycles. The frequency at which the arc becomes unstable, however, appears to be about as uncertain as the limit for incandescent lighting. It has been said that the fluctuations are discernible at 60 cycles, but it is quite common practice to supply enclosed arcs at that frequency in this country and 50 cycles abroad. Of course, there is no hard-and-fast critical point at which either class of lighting can be said to become generally impractical. With arcs, the length of arc, character of carbons and volume of current affect the behavior of the arc so as to vary the critical value of the frequency, while with incandescents the voltage and efficiency affect the critical point. Since it is practically certain, however, that arc lighting is out of the question at 30 cycles, and 60 cycles has become the standard moderate frequency, the actual low frequency limit for this class of service is not of so much importance as that for incandescent lamps. Some form of frequency changer must inevitably be employed in 25-cycle stations suppying arc lamps.

A Terrible Waste of Coal.

With this heading as its text and in the would-be superior tone that it habitually assumes in discussing technical subjects, *The New York Times* recently took occasion to ignore a few facts and distort a few others in order to create an opportunity to lecture "electricians" on their lack of humility and superabundance of homage-seeking, which exists solely in the imagination of the *Times*. Referring to the well-known low efficiency which characterizes the conversion of the heat energy in coal into luminous energy at the incandescent lamp filament, the writer of the article gives us a grain of credit for not claiming that the incandescent lamp converts into heat more than 4 to 6 per cent. of the energy delivered to it, and then proceeds: "As that loss is only the last of many—on the wires, in the dynamo, in the boiler and in the furnace, to mention only a few of the more important—the best that has been said for the incandescent lamp is that of the energy contained in the coal and converted into heat, it turns ½ of 1 per cent. into light." Then with a patronizing reference to the "more than a few powerful intellects struggling with the problem of getting the energy stored in coal at first hand instead of tenth or twentieth," we are admonished that "Meanwhile, the 'wonder-workers' might be a little more humble." As a half-statement of facts and a specimen of perverted logic this utterance fits in finely with the *Times'* system of technical argument. Incidentally, one might reasonably suppose that in view of the *Times'* record in the way of ludicrous technical blunders and sciolistic dicta a little more humility in its own household would not be unbecoming when a question of mixed thermodynamics and electrical engineering is involved. But reasonable suppositions don't fit the *Times'* case.

Steam Turbine Performance.

It would undoubtedly be of extremely great value to the central station industry at large if those stations which have installed steam turbines would make public the results of economy tests run under actual operating conditions after the apparatus has been in service for a reasonable period—say, six or twelve months. The statement has often been made, by impartial engineers as well as the manufacturers, that a properly designed turbine is inherently capable of maintaining its initial economy after a considerable period of service, and the simplicity of the rubbing surfaces makes this highly probable so far as those surfaces are concerned; but there is no information as to the rapidity of blade deterioration nor as to the effect of such wear on the general economy of the machine. On the face of it, one might reasonably suppose that the wear of blades and vanes would be almost negligible when operated with superheated steam, and that the shop test of a turbine outfit would therefore be a suitable criterion of its performance in the station for quite a respectable period of time. But suppositions are of little value in engineering, especially the commercial side of central station engineering, and a few confirmatory or modifying tests of turbine sets actually in service would be of inestimable value, not only to probable buyers but to the manufacturers themselves.

DESIGN AND CONSTRUCTION OF SMALL DYNAMOS AND MOTORS.

BY CECIL P. POOLE.

Miscellaneous Instructions.

The connections between field windings and terminal blocks and those from brush-holder studs to terminals should invariably be of stranded conductor, heavily insulated with rubber and an external braid. The leads from the field winding may usually be of No. 14 B. & S. gauge, but for machines of 10 kilowatts and over, it will be found more satisfactory to use No. 12 stranded wire on account of the greater ruggedness of the material. The leads from the brush-holder studs should be of sufficient cross-

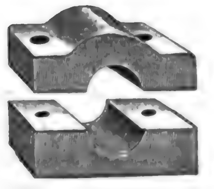


FIG. 1.

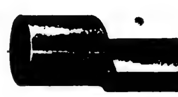


FIG. 2.

section to come within the limits set by Table XVI, and they should be long enough to permit any transposition that might be found advisable after the machine is put into service.

TABLE XVI.—MAXIMUM ALLOWABLE CURRENT IN MAIN LEADS FROM BRUSHES.

Equivalent size; B. & S. gauge.	Amperes.	Equivalent size; B. & S. gauge.	Amperes.
14	9	3	60
12	12	2	70
10	18	1	80
8	25	0	95
6	33	00	110
5	42	000	135
4	50	0000	160

The terminal blocks should be made of slate or marble, mounted on kiln-dried wood to reduce the shocks due to moving the machine around; the wood base should be made up in at least two, and preferably three, layers, the grain being crossed in the adjacent layers. The terminals may be in the form of ordinary binding posts for currents of 25 amperes or less, but in all cases the binding screw should be large in diameter and provided with a large milled head for setting it up by hand; an ordinary screw requiring the use of a screwdriver should never be used. For currents above 25 amperes, the terminals should be either of the clamp type indicated in Fig. 1, the leads being equipped with soldered lugs to fit the opening between the clamp members, or else simple metal blocks, carefully faced off and of the proper size to accommodate the flat part of a lug like that shown in Fig. 2. This lug is, of course, soldered to the end of the lead.

The instructions given in the preceding articles are sufficiently general to cover any voltage for which the amateur may wish to build his machine, excepting the data contained in Tables I and XI relating to armature current per wire and to the size of wire to be used in the field-magnet winding, respectively. In order to ascertain the armature current per wire for machines of other voltages than the standards specified in the table, it is only necessary to divide the armature watts by the voltage and then divide the result by the number of paths

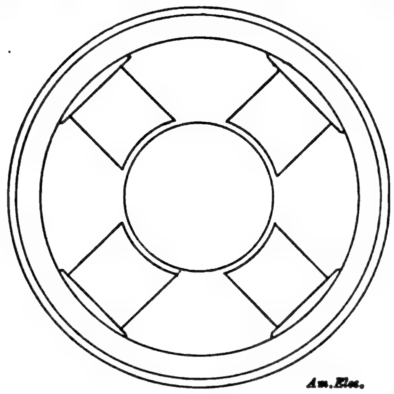


FIG. 3.

in the armature winding. Having the current per wire, Tables III, IV and VI may be applied to any machine, no matter what its e.m.f.

In order to apply Table XI to a machine of special voltage, one needs only to ascertain the size of wire that would have to be used for the nearest standard voltage and then make correction by means of Table XVII, as follows:

In the proper line at the top of the proper section of the table, find the size of wire required for the nearest standard voltage; in the same column in the body of the table find the nearest voltage to that of the machine, then trace horizontally along the line in which this voltage is found until the extreme right-hand column is reached. The number in that column will be the proper size of wire to use. Example: Suppose that the actual voltage of the machine is to be 60 volts, and the excitation test, made with No. 16 wire, showed 86 volts necessary to excite the field; Table XI, first section, would show that for 110 volts, the field winding would need to be of No. 17 wire. Now, referring this to Table XVII, first section, No. 17 is located in the upper (110-volt) headline of the table in the fifth column, and tracing down this column into the body of the table, the number 55 is found to be the nearest to the voltage of the machine. Tracing to the right along this line,

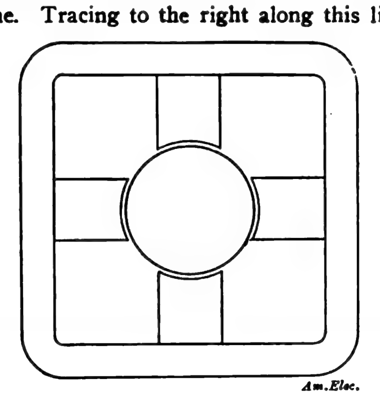


FIG. 4.

in the right-hand column is found the number 14, and this is the size of wire to be used. If the machine voltage had been 7 instead of 60, the nearest number in the fifth column would have been 6.8, and the size of wire in line with this is 5, which would have been the proper size to use for 7 volts.

In connecting the armature winding of a machine to the commutator lugs it is advisable to keep in mind the disposition of the field magnet poles about the axis and to carry the armature leads to the commutator in such a way as to cause the most favorable location of the brushes about the commutator. In the case of a four-pole machine, it is always advisable to have the brushes make contact on the commutator 90 degrees each side of the vertical diameter, no matter whether there be two or four brush positions. If the field magnet poles are distributed as in Fig. 3, then in order to get the brush contacts 90° from the vertical diameter the two leads from each coil must be bent sidewise equal distances from the center of the coil, as indicated diagrammatically in Fig. 5, for a wave-connected winding. For a lap winding, the

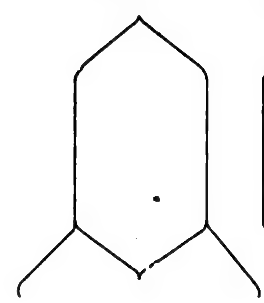


FIG. 5.

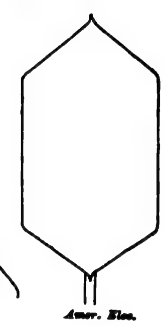


FIG. 6.

leads must go to the commutator as nearly opposite the center of the coil as possible, as indicated diagrammatically in Fig. 6.

When the magnet poles are arranged as in Fig. 4, one lead of each armature coil must go to the commutator segment opposite the "side" of the coil from which the lead is taken, as indicated in Figs. 7 and 8 for wave-connected and lap windings, respectively. Consideration of Fig. 8 will show that the arrangement of the lead, *a*, is awkward in the extreme, and as a matter of fact it would be almost impracticable to carry out the lead in this fashion in actual work; a much better disposition of it is to carry it past the central bend of the coil and over to the point where the other lead comes out from the taping, as indicated by the dotted lines. Most armature winders bring

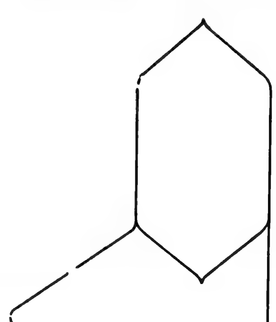


FIG. 7.

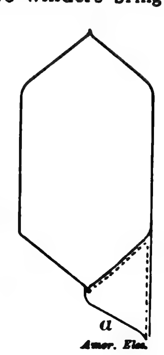


FIG. 8.

both leads out from the center of the coil, as in Fig. 6, and bend both of them to the right or left a distance equal to one-half of the magnet pole pitch, but the arrangement of Fig. 8, substituting the dotted line arrangement of the lead *a*, is much prefer-

able, for the reason that the leads then go straight out to the commutator and do not require to be "bedded" closely together, as on the horizontal diameter of the yoke ring, the other four being arranged, of course, in pairs with the two poles of each pair equal of the winding. Then, with a wave-connected winding and two groups of brushes, the brushes should touch the commutator at

TABLE XVII-A.

For deriving proper size of wire for field winding at special voltage.

Wire size for 110 volts: 13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	Wire Size for Actual E. M. F.
Wire size for 220 volts: 16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
6.8	5.4	4.3	3.4	2.7		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2 No. 4's
8.6	6.9	5.4	4.3	3.4	2.7	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2 No. 5's
10.9	8.6	6.9	5.4	4.3	3.4	2.7	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2 No. 6's
13.7	10.8	8.6	6.8	5.4	4.3	3.4	2.7	..	..	..	..	..	..	..	..	..	..	..	..	..	..	4
17.2	13.7	10.8	8.6	6.8	5.4	4.3	3.4	2.7	..	..	..	..	..	..	..	..	..	..	..	..	..	5
21.7	17.2	13.7	10.8	8.6	6.8	5.4	4.3	3.4	2.7	..	..	..	..	..	..	..	..	..	..	..	..	6
27.4	21.7	17.2	13.7	10.8	8.6	6.8	5.4	4.3	3.4	2.7	..	..	..	..	..	..	..	..	..	..	..	7
34.5	27.4	21.7	17.2	13.7	10.8	8.6	6.8	5.4	4.3	3.4	2.7	..	..	..	..	..	..	..	..	..	..	8
43.5	34.5	27.4	21.7	17.2	13.7	10.8	8.6	6.8	5.4	4.3	3.4	2.7	..	..	..	..	..	..	..	..	..	9
55.	43.5	34.5	27.4	21.7	17.2	13.7	10.8	8.6	6.8	5.4	4.3	3.4	2.7	..	..	..	..	..	..	..	..	10
69.	55.	43.5	34.5	27.4	21.7	17.2	13.7	10.8	8.6	6.8	5.4	4.3	3.4	2.7	..	..	..	..	..	..	..	11
87.5	69.	55.	43.5	34.5	27.4	21.7	17.2	13.7	10.8	8.6	6.8	5.4	4.3	3.4	2.7	..	..	..	..	..	..	12
110.	87.5	69.	55.	43.5	34.5	27.4	21.7	17.2	13.7	10.8	8.6	6.8	5.4	4.3	3.4	2.7	..	..	..	..	..	13
139.	110.	87.5	69.	55.	43.5	34.5	27.4	21.7	17.2	13.7	10.8	8.6	6.8	5.4	4.3	3.4	2.7	..	..	..	..	14
175.	139.	110.	87.5	69.	55.	43.5	34.5	27.4	21.7	17.2	13.7	10.8	8.6	6.8	5.4	4.3	3.4	2.7	..	..	..	15
220.	175.	139.	110.	87.5	69.	55.	43.5	34.5	27.4	21.7	17.2	13.7	10.8	8.6	6.8	5.4	4.3	3.4	2.7	..	..	16
278.	220.	175.	139.	110.	87.5	69.	55.	43.5	34.5	27.4	21.7	17.2	13.7	10.8	8.6	6.8	5.4	4.3	3.4	2.7	..	17
350.	278.	220.	175.	139.	110.	87.5	69.	55.	43.5	34.5	27.4	21.7	17.2	13.7	10.8	8.6	6.8	5.4	4.3	3.4	2.7	18
	350.	278.	220.	175.	139.	110.	87.5	69.	55.	43.5	34.5	27.4	21.7	17.2	13.7	10.8	8.6	6.8	5.4	4.3	3.4	19
		350.	278.	220.	175.	139.	110.	87.5	69.	55.	43.5	34.5	27.4	21.7	17.2	13.7	10.8	8.6	6.8	5.4	5.3	20
			350.	278.	220.	175.	139.	110.	87.5	69.	55.	43.5	34.5	27.4	21.7	17.2	13.7	10.8	8.6	6.8	5.4	21
				350.	278.	220.	175.	139.	110.	87.5	69.	55.	43.5	34.5	27.4	21.7	17.2	13.7	10.8	8.6	6.8	22
					350.	278.	220.	175.	139.	110.	87.5	69.	55.	43.5	34.5	27.4	21.7	17.2	13.7	10.8	8.6	23
						350.	278.	220.	175.	139.	110.	78.5	69.	55.	43.5	34.5	27.4	21.7	17.2	13.7	10.8	24
							350.	278.	220.	175.	139.	110.	87.5	69.	55.	43.5	34.5	27.4	21.7	17.2	13.7	25
								350.	278.	220.	175.	139.	110.	87.5	69.	55.	43.5	34.5	27.4	21.7	17.2	26
									350.	278.	220.	175.	139.	110.	87.5	69.	55.	43.5	34.5	27.4	21.7	27
										350.	278.	220.	175.	139.	110.	87.5	69.	55.	43.5	34.5	27.4	28
											350.	278.	220.	175.	139.	110.	87.5	69.	55.	43.5	34.5	29
												350.	278.	220.	175.	139.	110.	87.5	69.	55.	43.5	30
													350.	278.	220.	175.	139.	110.	87.5	69.	55.	31
														350.	278.	220.	175.	139.	110.	87.5	69.	32
															350.	278.	220.	175.	139.	110.	87.5	33
																350.	278.	220.	175.	139.	110.	34
																	350.	278.	220.	175.	139.	35
																		350.	278.	220.	175.	36

TABLE XVII-B.

For deriving proper size of wire for field winding at special voltage.

Wire size for 250 volts: 16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	Wire Size for Actual E. M. F.
Wire size for 500 volts: 19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	
157	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	14
200	157	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	15
250	200	157	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	16
315	250	200	157	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	17
397	315	250	200	157	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	18
500	397	315	250	200	157	...	...	...	...	...	...	...	...	...	...	...	...	...	...	19
630	500	397	315	250	200	157	...	...	...	...	...	...	...	...	...	...	...	...	...	20
	630	500	397	315	250	200	157	...	...	...	...	...	...	...	...	...	...	...	...	21
		630	500	397	315	250	200	157	...	...	...	...	...	...	...	...	...	...	...	22
			630	500	397	315	250	200	157	...	...	...	...	...	...	...	...	...	...	23
				630	500	397	315	250	200	157	...	...	...	...	...	...	...	...	...	24
					630	500	397	315	250	200	157	...	...	...	...	...	...	...	...	25
						630	500	397	315	250	200	157	...	...	...	...	...	...	...	26
							630	500	397	315	250	200	157	...	...	...	...	...	...	27
								630	500	397	315	250	200	157	...	...	...	...	...	28
									630	500	397	315	250	200	157	...	...	...	...	29
										630	500	397	315	250	200	157	...	...	...	30
											630	500	397	315	250	200	157	...	...	31
												630	500	397	315	250	200	157	...	32
													630	500	397	315	250	200	157	33
														630	500	397	315	250	200	34
															630	500	397	315	250	35
																630	500	397	315	36
																	630	500	397	37

they do when carried diagonally to the commutator.

The field magnet of a small six-pole machine should always be built with two poles distances from the vertical diameter of the machine. The leads from the armature to the commutator should be carried out as in Fig. 5 or Fig. 6, according to the character the ends of the horizontal diametrical line; with six groups of brushes, each group will set practically opposite the center of a field magnet pole.

POWER HOUSE NOTES.

BY ARTHUR B. WEEKS.

In a certain power house, it was found necessary to increase the field strength of a rotary converter. The original field winding was as shown on the machine on the right of Fig. 1. As there was not sufficient space for making a larger field-magnet coil wound in like manner, each new field coil was divided into two parts, with ventilating

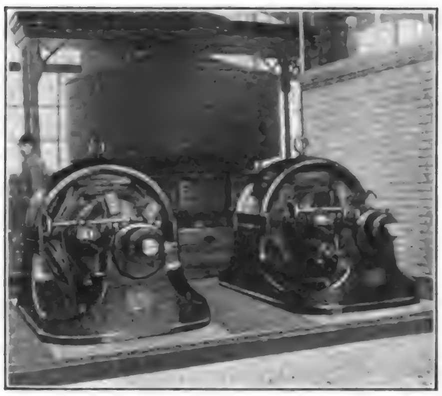


FIG. 1.—ROTARY CONVERTERS.

spaces between, as shown in the rotary at the left of the illustration. Fig. 2 gives a clearer idea of the arrangement. To drill the holes in the field-magnet core for securing the new coils, a ratchet drill and "old man" were utilized. At one time the field-magnet coils of one of these machines were badly scorched, because the operator in opening the switches neglected to pull out the alternating-current plug switches. When the current was thrown on the bus-bars again, the field winding was burned out, and it was replaced with the divided form of coil.

Before installing the new coils, they were laid out on the floor and tested for polarity, as shown in Fig. 3; the two coils per pole are represented by the large and small squares. Current was supplied by the other rotary for testing. The coils alternate in polarity, of course, this being made sure by testing with a dipping magnetic needle which is free to turn completely over.

Rotary converters can be used as ex-

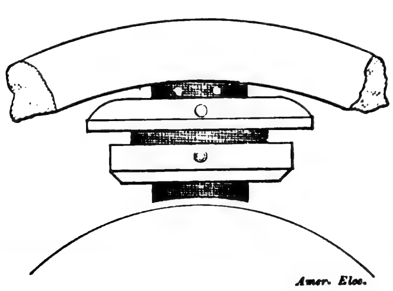


FIG. 2.—FIELD COILS OF ALTERED ROTARY.

citers with gratifying results, and with but one drawback; when there is a short-circuit on the lines, the machines stop, of course, their source of current being cut off, and direct current must be available in order to start up the plant without waiting for the alternating-current trouble to be cleared. Another, but less important disadvantage is that if the direct-current bus-bar switches are opened and one forgets to open the alternating-current switches, when the current is thrown on the bus-bars again the

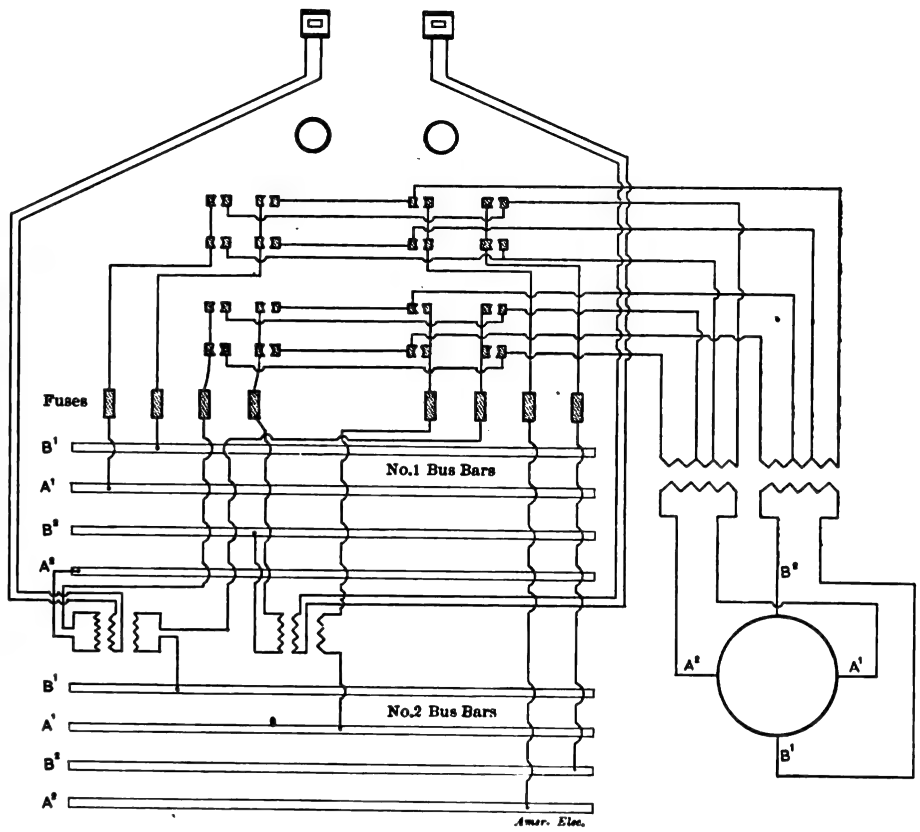


FIG. 5.—DIAGRAM OF CONNECTIONS.

armature cannot revolve, and if the neglect is not discovered in time the field-magnet coils will burn out. This trouble, however, should not occur in any well-attended station.

Fig. 4 shows a panel for one of the rotaries already mentioned. There are a direct-current voltmeter, a direct-current ammeter, and two alternating-current ammeters, one for each set of bus-bars. Plug switches are used. As shown, the switches are on bus-bars No. 2. At the small panel in front are the field rheostat wheel, a lever controlling the direct-current circuit-breaker, an alternating-current changing switch, and levers for direct-current bus-bar switches Nos. 1 and 2. The rotary, which is a two-phase machine, can be run from either the No. 1 or the No. 2 alternating-

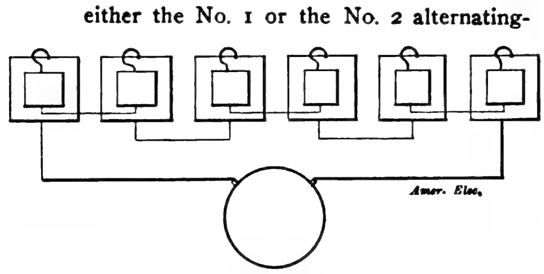


FIG. 3.—TESTING POLARITY OF COILS.

current bus-bars, or both, and supply direct current to either or both of the direct-current bus-bars, as will be evident from Fig. 5. The machine can be operated from both sets of the alternating-current bus-bars simultaneously only when these are in parallel, of course; failure to remember this would cause trouble if the other alternating-current plug switches were pushed in during the running of the machine.

Direct-current exciters can be run in parallel on direct-current bus-bars with rotary converters, but the voltage and speed of the direct-current machines must, of course, be properly regulated to enable them to take their proper part of the load.

The usual method of starting large rotary converters is to plug them in on the line at the alternating-current side while at a standstill. This causes a very bad surge

FIG. 4.—SWITCHBOARD PANEL FOR ROTARY.

in the line voltage, and as often as the converter does not build up right the operation must be repeated. This and other bad features of starting may be avoided by connecting up an alternator on these bars, separately excited by itself and running at slow speed and with a very weak field; then closing the feeder switch and trying the

rotary. If the polarity is right, the generator speed and field strength are increased until the running voltage is attained. If desired, this alternator may then be paralleled with the others on the other bus-bars. After one rotary has been started, as just described, others may be started as usual on the direct-current side.

To start a rotary converter with connections as in Fig. 5, all the switches at the upright panel and the small panel at the front must be open; then the changing switch on the small panel at the alternating-current side is closed and plugs inserted in the two lower plug sockets on the main board. These represent one leg of each phase. Next, two plugs are put in the two upper receptacles. If the machine builds up right, the changing switch is thrown from the alternating-current to the direct-current side, and the two top switch plugs are changed one at a time to the next lower receptacles. In the first position, choke coils were in circuit; the next operation cuts them out. The phases are arranged vertically on the board, not across it. The field strength is then increased until normal voltage is attained. If the field is too strong the ammeter will indicate excessive alternating current. Should the machine not build up right in starting, the last two plug switches are withdrawn and another attempt made after a wait of a few moments.

LOCATION AND CARE OF STEAM GAUGES.

BY W. H. WAKEMAN.

As principles which cause steam gauges to give correct results are not always understood by men who have charge of them, the following illustrations and explanations

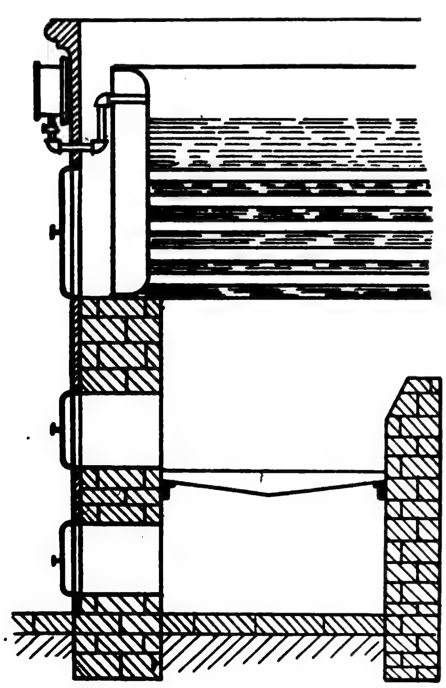


FIG. 1.

taken from everyday practice will doubtless be of interest.

Fig. 1 shows a method of connecting gauges adopted by a firm that turns out hundreds of good tubular boilers. A one-quarter inch pipe is connected into the front head above the water line. A loop is formed

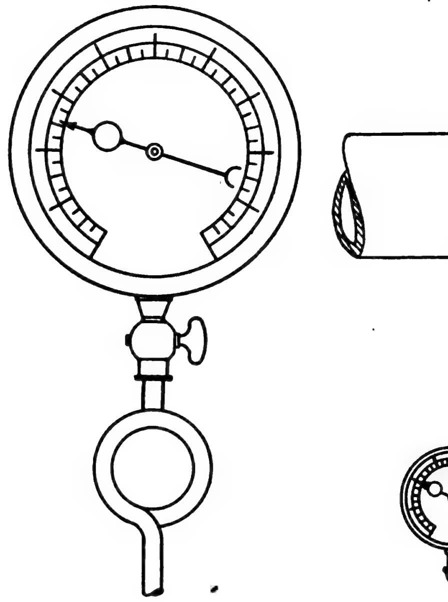


FIG. 2.

by nipples and ells, which causes water to stand in this pipe, thus protecting the gauge from the heat of the steam.

This method of connection works fairly

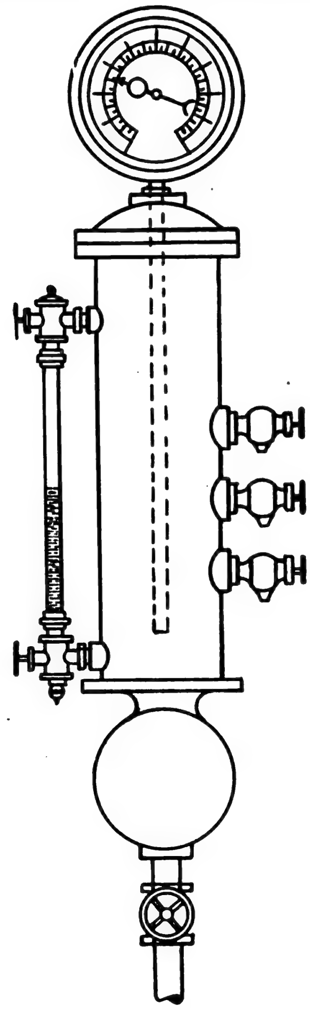


FIG. 3.

well when the boiler is under a light load, but when the boiler is worked to its full capacity this little pipe is in the midst of hot gases on their way to the chimney, which heat it, and probably evaporate the water in the loop.

To avoid this possible danger these pipes may be taken out of the boiler and located in plain sight. Each loop is connected into another pipe without a valve between this connection and the steam space of boiler, although a valve may be placed in the small

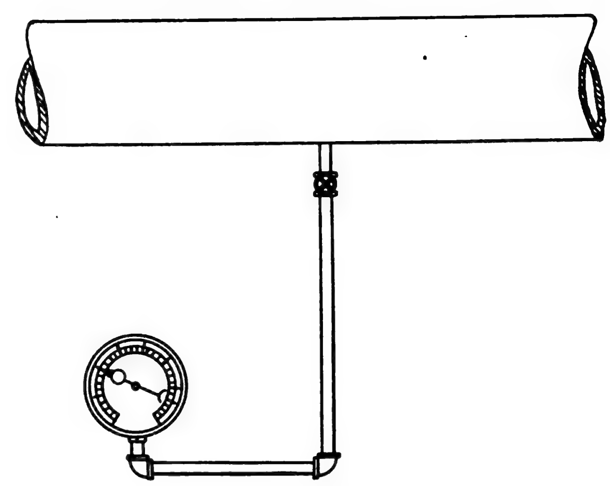


FIG. 4.

pipe near the connection. It is customary to locate a double ended pet cock under the gauge in such a case, but it is omitted here, therefore leaks from this source do not annoy the fireman by dropping water on the furnace doors.

A union is located at this point so that when the pipe needs cleaning the one-quarter-inch valve is closed, the union disconnected and the valve opened under a full head of steam, thus blowing out all sediment. After this the pipe is allowed to cool; then the union is connected and steam turned on. Enough steam is condensed to protect the gauge. Where a pet cock is provided in a connecting pipe it is customary in some plants to draw the water out of this pipe frequently without shutting off the gauge, but this is wrong, because heat thus admitted to the spring injures it. Brass pipe should be used for such service as it does not corrode as quickly as iron pipe.

The siphon shown in Fig. 2 keeps water in the pipe at all times, but it has a disadvantage in that there is no provision made for cleaning it without disconnecting the gauge. Water cannot be drained out, so that if the gauge is located in an exposed position the water is liable to freeze in cold weather, thus preventing the gauge from indicating correct pressure. Accidents have happened from this cause in the past, and probably will in the future.

Fig. 3 shows another plan for protecting a gauge. Under normal conditions this gives good results; but when the lower drip valve is opened to blow sediment out of the column, the end of the connecting pipe, shown in dotted lines, is above the water line, so that steam is admitted to the gauge, endangering the spring.

The supposition that a good gauge will always correctly indicate the boiler pressure, regardless of the way in which it is connected, is erroneous, as the following illustrations will show.

Fig. 4 represents a low-pressure gauge attached to a steam heating main. A column

of water always stands in this pipe, and the vertical distance from the center of the gauge to the top of this water is 8 feet 4 inches. The actual pressure at this point, without steam in the main pipe, is 3.6 pounds, due to the weight of the water. The dial of this gauge is graduated into pounds, so that the indicators should stand at about three-quarters of the distance between 3 and 4 pounds, when no steam is in the mains. When reading the pressure on this heating main, this amount should be subtracted from the pressure the gauge indicates.

Fig. 5 illustrates a gauge located on the floor above the boiler room. If a gauge so placed is piped so that all water drains back into the boiler, it will indicate correctly; but

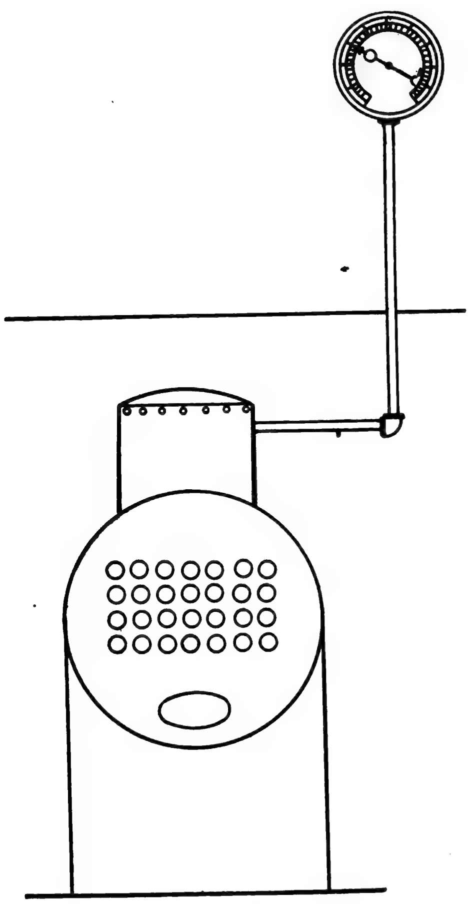


FIG. 5.

if the connecting pipe contains water, the gauge will indicate one pound less than correct steam pressure for each 27.7 inches vertical height of water. In other words, the result will be directly opposite to that obtained with the arrangement shown in Fig. 4, although both gauges may be correct.

Fig. 6 shows a steam gauge attached to a Manning boiler. It is connected into the shell just above the crown sheet, consequently the weight of water above the gauge creates a pressure which must be subtracted from the indicated pressure to obtain the true head of steam carried.

In a plant where this kind of boiler is in use, the inspector objected to the pressure carried, as it was more than 5 pounds above the limit fixed. The engineer claimed that he was allowed to carry a certain steam pressure, and that the water as above described, was responsible for the surplus pressure indicated. Now, the safe working pressure of a boiler as fixed by an insurance company, is based on the estimated strength of the shell, heads and tubes; consequently the limit should not be exceeded, regardless of what causes said pressure. If a gauge located as shown in Fig. 6 shows

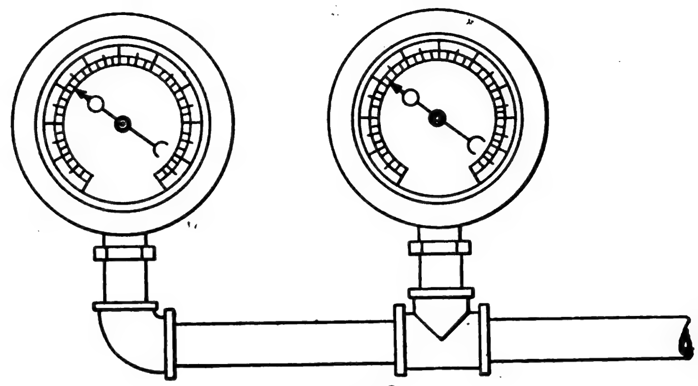


FIG. 8.

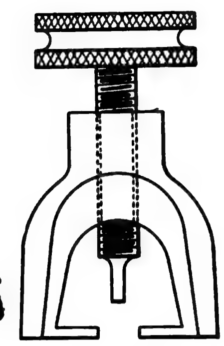


FIG. 9.

100 pounds, 10 of which are due to weight of water, it is the same as if 100 pounds of steam was carried on a horizontal boiler, or one of the water-tube type where the height of water is not enough to make much difference, therefore the gauge should never show more than the amount allowed.

Of course this ruling gives less available pressure for a vertical than for a horizontal boiler, and the difference is enough in many cases to seriously affect the engines using steam, but it keeps one on the safe side, which is a very important point.

Although a steam gauge may be correct when new, it does not necessarily follow

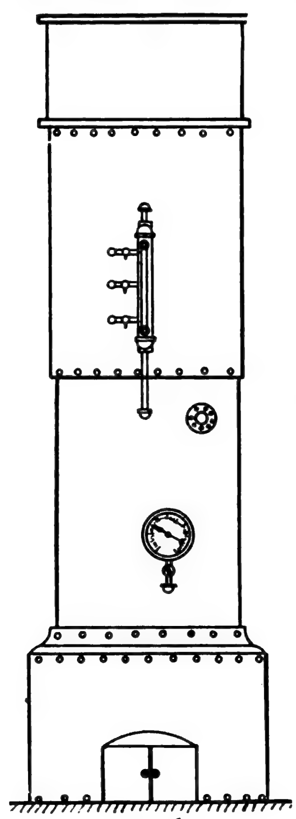


FIG. 6.

that it will remain so, therefore every gauge should be tested at least once a year. This does not mean that in a plant where a score or more are in use, each one should be disconnected and tested separately, as that plan would make much unnecessary work. If a certain gauge is tested each year, and all others indicate similar pressure, where they are connected in the same way, no further proof of their accuracy is needed. Where they are connected in different ways and indicate different pressures, if they maintain the same difference towards the one tested, it shows that no change has taken place in them, and this is sufficient proof of their condition.

Fig. 7 illustrates an instrument for testing gauges. The body is partly filled with oil and a small plunger inserted. This carries with it a circular platform upon which the desired number of weights are placed. Five are shown in the illustration, the three bottom ones indicate 20 pounds each, the next indicates 10 and the top one 5 pounds pressure to the square inch, consequently when the adjusting handle is screwed inward, so as to just float the tightly fitting plunger in the oil, the pointer will indicate 75 pounds if all parts are properly adjusted.

As such an instrument is expensive, it is not always available for testing purposes. A good substitute, which can be made by any engineer, is illustrated in Fig. 8. A gauge known to be correct is connected into a tee as shown and one to be tested connected in parallel with it. The full working pressure of steam is then turned on and the indications of the pointers compared. If the indicators do not agree the

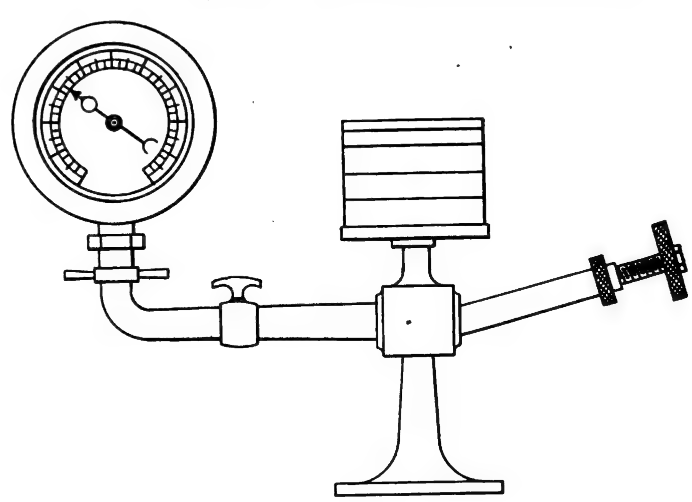


FIG. 7.

one from the defective gauge is removed and replaced so as to agree with the other. A little instrument that is very convenient for this purpose is shown in Fig. 9 and its application is illustrated in Fig. 10. Screwing down the gnarled handle draws

the pointer upward, unseating it from the central pivot, after which it is forced on again, care being taken to place it so as to agree with the other gauge.

The advisability of adjusting a gauge ac-

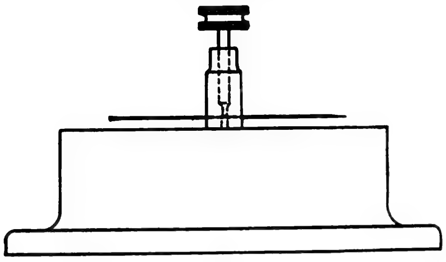


FIG. 10.

cording to this method has been disputed, but it certainly indicates the correct working pressure, if directions are followed, and that is the object sought.

DISEASES OF ELECTRICAL MACHINERY.

BY F. B. CROCKER AND S. S. WHEELER.

D. Heating of Field-Magnets.

All direct-current generators and motors as well as alternating-current generators, synchronous motors and rotary converters, have field magnets excited by direct current. Induction motors and generators, also single-phase, self-starting motors, carry alternating current in their field coils, but the following troubles might occur in any of these types:

Cause 1.—Excessive current in field circuit.

Symptom.—Field coils too hot to be bearable to the hand. Their temperature more than 50 degs. C. above that of the room by resistance test or 50 degs. C. by thermometer. (See methods already given.)

Remedy.—In the case of a shunt-wound or separately excited machine decrease the voltage at terminals of field coils, or increase the resistance in field circuit by winding on more wire or by putting resistance in series. In the case of a series-wound machine, shunt a portion of, or otherwise decrease, the current passing through the field, or take a layer or more of wire off the field coils, or rewind with coarser wire. This trouble might be due to a short-circuit in field coils in the case of a shunt-wound or separately excited generator or motor, and would be indicated by one pole-piece with the short-circuited coil being weaker than the others; a wholly or partially short-circuited field coil being also *cooler* than the others. The short-circuiting of a portion of the field circuit may not cause serious harm. In this respect it differs radically from a short circuit of even one turn of wire in the armature. (See "Sparking," Cause 5.) Measure resistance of field coils to see if they are nearly equal. If the difference is considerable (*i.e.*, more than 5 per cent.), it is an almost sure sign that one coil is short-circuited or double-grounded. (See "Sparking," Causes 8 and 9.)

Cause 2.—Eddy or Foucault currents in pole pieces.

Symptom.—The pole pieces hotter than the coils after a short run.

Remedy.—This trouble is either due to faulty design and construction, which can only be corrected by rebuilding, or else it is caused by fluctuations in the current. The latter can be detected if the variations are not too rapid, by putting an ammeter in circuit, or rapid variations may be felt by holding a piece of iron near the pole pieces and noting whether it vibrates. In the case of an alternating current it is necessary to use laminated fields to avoid great heating, and the ordinary arc currents fluctuate enough to cause some trouble in this way. In fact, the currents generated by the open-coil armatures used in arc lighting (Thomson-Houston and Brush) are decidedly pulsating in character. With this exception, however, direct currents rarely pulsate sufficiently to cause heating due to eddy currents.

Cause 3.—Moisture in field coils.

Symptom.—Field-circuit tests lower in resistance than normal in that type of machine, and in the case of shunt-wound machines the field takes more than the ordinary current. Field coils steam when hot, or feel moist to hand. The insulation resistance also tests low.

Remedy.—The same as for moisture in armature. (Heating of Armature, Cause 3.)

E. Heating of Bearings.

This may arise in almost any machine, including all direct-current as well as alternating-current generators and motors. The cause should be found and removed promptly, but heating of the bearings may be reduced temporarily by applying cold water or ice to them. This is only allowable when it is absolutely necessary to keep running, and great care should be taken not to allow any water to get upon the commutator, armature, or field coils, as it might short circuit or ground them. If the bearing is very hot, the shaft should be kept revolving slowly, as it might "freeze" or stick fast if stopped entirely.

Cause 1.—Lack of oil.

Symptom.—Oil cup or reservoir empty. Oil passages clogged. Self-oiling rings, or other devices not revolving or acting properly. Shaft and bearing look dry. The shaft does not turn freely.

Remedy.—Supply oil, and make sure that oil passages as well as feeding or self-oiling devices work freely, and that the oil cannot leak out. This last fault sometimes causes oil to fail sooner than attendant expects. Good quality of oil should always be used, as poor oil might be as bad as no oil.

Cause 2.—Grit or other foreign matter in bearings.

Symptom.—Best detected by removing shaft or bearing and examining both. Any grit can, of course, be felt easily, and will also scratch the shaft.

Remedy.—Remove shaft or bearing, clean both very carefully, and see that no grit can get in. Place machine in a dustless place or box it in. The oil should be perfectly clean; if not, it should be filtered. If it is not possible to stop the machine or to remove the shaft the dirt might be washed out with kerosene or water, but these should not be allowed to get on the commutator, armature, or field coils, and should be removed as completely as possible afterward, lubricating oil being again introduced.

Cause 3.—Shaft rough or cut.

Symptom.—Shaft will show grooves or roughness, and will probably not revolve freely.

Remedy.—Turn shaft in lathe or smooth with fine file, and see that bearing is smooth and fits shaft.

Cause 4.—Shaft and journal fit too tight.

Symptom.—Shaft does not turn easily, but excessive friction is immediately and completely relieved by slight loosening in the case of a split journal. In case the latter is not split, the bearing cap may be removed, and the journal examined to see whether it grips the shaft tightly.

Remedy.—Turn or file down shaft in lathe, or scrape or ream out journals.

Cause 5.—Shaft "sprung" or bent.

Symptom.—Shaft hard to revolve, and usually sticks much more in one part of its revolution than in another.

Remedy.—It is very difficult to straighten a bent shaft. It might be bent back or turned true, but probably a new shaft will be necessary.

Cause 6.—Bearings out of line.

Symptom.—Shaft does not revolve freely, but is much relieved by slightly loosening the screws which hold bearings in place.

Remedy.—Loosen the bearings by partly unscrewing bolts or screws holding them in place, and find their easy and true position, which may require one of them to be moved either sideways or up and down; then file the screw-holes of that bearing or raise or lower it, as may be necessary, to make it occupy the right position when the screws are tightened. The revolving part must be kept, however, in the center of the space in which it turns, so that the clearance is uniform all around. (See Cause 9.)

Cause 7.—Thrust or pressure of pulley, collar, or shoulder on shaft against one or both of the bearings.

Symptom.—In the case of a belt-connected machine, move the shaft back and forth with a stick applied to the end while revolving, and note whether the collar or shoulder tends to be pushed or drawn against either bearing. It is usually desirable that a shaft should move freely back and forth an eighth of an inch to make the commutator and bearings wear smooth. (See "Sparking," Cause 3.)

Remedy.—Line up the belt, shift the collar or pulley, turn off the shoulder on shaft or file off the bearing until the shoulder does not touch when running or until pressure is relieved.

Cause 8.—Too great load or strain on the belt.

Symptom.—Great tension on belt. The pulley bearing is probably much hotter than the other, and in time will be worn elliptical, in which case the shaft may be shaken in the bearing in the direction of the belt pull, when the belt is off.

Remedy.—Reduce the load or belt tension, or use larger pulleys and lighter belt, so as to relieve side strain on shaft.

Cause 9.—Armature nearer the pole pieces on one side, producing greater magnetic attraction on nearer side.

Symptom.—Examine the clearance to see if it is uniform on all sides. Charge and discharge the field magnet, the armature being disconnected (by lifting the brushes or otherwise), and note whether armature seems to be drawn to one side and turns very much less easily when field is magnetized.

Remedy.—See "Sparking," Cause 9, and remedy therefor. This condition does not produce sparking or armature heating except in multipolar direct-current machines with multiple-circuit armature windings. It can produce heating of bearings in any machine, but is worse with multipolar than with bipolar machines; therefore, the clearance between the armature and pole pieces should be larger in the former than in the latter. This difficulty always tends to become aggravated, because the more the side pull, the more the bearings wear in that direction. If, on the other hand, the armature is in the center of the space formed by the pole pieces, the magnetic pull is practically balanced in all directions.

Cause 10.—Bearing heated by hot pulley, commutator, or armature.

Symptom.—Pulley, armature, or commutator hotter than bearing. The slipping of the belt on the pulley, sparking at the commutator, or heating of the armature may heat one or both bearings of the machine, in which case an examination will show that these parts are hotter than the bearing and are the real source of the trouble.

Remedy.—A slipping belt, sparking commutator, or hot armature can be cured as described under these headings, and then the bearing will probably cease to heat.

F. Noisy Operation.

This trouble may occur in any electrical machine, except that Cause 5 (noise due to brushes) is not likely to be serious in alternating-current machines having no commutator. Nevertheless, the brushes on the collector rings may make a noise, for example, when the latter are rough.

Cause 1.—Vibration due to armature, revolving field, pulley or other moving part being out of balance.

Symptom.—Strong vibration felt when the hand or a stick of wood is placed upon the machine while it is running. Vibration changes greatly if the speed is changed, and sometimes almost disappears at certain speeds.

Remedy.—Armature, pulley or other revolving part must be perfectly balanced by *securely* attaching lead or other weight on the light side, or by drilling or filing away some of the metal on the heavy side. The easiest method of finding in which direction it is out of balance is to take it out and rest the shaft on two parallel and horizontal A-shaped metallic tracks sufficiently far apart to allow the armature to go between them. If the armature is then slowly rolled back and forth, the heavy side will tend to turn downward. The armature and pulley should always be balanced separately. An excess of weight on one side of the pulley and an equal excess of weight on the opposite side of the armature will not produce a balance while running, though it does when standing still; on the contrary, it will give the shaft a strong tendency to "wobble." A perfect balance is only obtained when the weights are directly opposite, *i.e.*, in the same line perpendicular to the shaft.

Cause 2.—Armature strikes or rubs against pole pieces.

Symptom.—Easily detected by placing the ear near the pole pieces or by examining armature to see if its surface is abraded at any point, or by examining each part of the space between armature and field, as armature is slowly revolved, to see if any portion of it touches or is so close as to be likely to touch when the machine is running. In small machines the armature may be turned slowly by hand or with a lever to ascertain whether it tends to touch or "stick" at any point.

Remedy.—Bind down any wire or other part of the armature that may project abnormally; chip or file out the pole pieces where the armature strikes; or center the armature so that there is a uniform clearance between it and the pole pieces at all points.

Cause 3.—Shaft collar or shoulder, hub or edge of pulley, or belt strikes or scrapes against bearings.

Symptom.—Rattling noise, which stops when the shaft, pulley or belt is pushed lengthwise away from one or the other of the bearings. (See "Heating of the Bearings," Cause 7.)

Remedy.—Shift the collar or pulley, turn off the shoulder on the shaft, file or turn off the bearing, move the pulley on the shaft or straighten the belt until there is no more striking and noise ceases.

Cause 4.—Rattling due to looseness of screws or other parts.

Symptom.—Close examination of the bearings, shaft, pulley, screws, nuts, binding posts, etc., or touching the machine while running or shaking its parts while standing still, shows that some part is loose.

Remedy.—Tighten up the loose parts, and be careful to keep all properly set up. It is an easy matter to guard against the occurrence of this trouble, which is very common, by simply examining the various screws and other parts each day before the machine is started. Electrical machinery being usually high speed, the parts are particularly liable to shake loose. A worn or poorly fitted bearing might allow the shaft to rattle and make a noise, in which case the bearing should be refitted or renewed.

Cause 5.—Humming, squeaking or hissing of brushes.—This is often occasioned by rough or sticky commutator (see "Sparking," Causes 3 and 4). The commutator and brushes of a new machine may make considerable noise that is reduced after it has been running for a day or two.

Symptom.—Sound of high pitch, and easily located by placing the ear near the commutator while it is running, and by lifting off the brushes one at a time, provided that the circuit is not opened thereby.

Remedy.—Apply a *very little* oil or vaseline to the commutator with the finger or a rag. Adjust the brushes or smooth the commutator by turning, filing, or fine sandpaper, being careful to clean thoroughly afterwards. Carbon brushes are apt to squeak in starting up or at low speed. This decreases at full speed, and can usually be reduced by slightly moistening the brush with oil, care being taken not to have any drops or excess of oil. Shortening or lengthening the brushes sometimes stops the noise. Run the machine with little or no load until the commutator and brushes are worn smooth.

Cause 6.—Flapping or pounding of belt joint or lacing against pulley.

Symptom.—Sound repeated once for each complete revolution of the belt, which is much less frequent than any other generator or motor sound, and can easily be detected or counted.

Remedy.—Endless belt or smoother joint.

Cause 7.—Slipping of belt on pulley due to overload.

Symptom.—Intermittent squeaking noise.

Remedy.—Tighten the belt or reduce the load. A wider belt or larger pulley may be required. Powdered rosin may be put on the belt to increase its adhesion; but it is a makeshift, injurious to the belt, only to be adopted in an emergency. Special belt dressings are sold, which increase the adhesion and at the same time are intended to preserve the belt.

Cause 8.—Humming of armature core teeth as they pass pole pieces.

Symptom.—Pure humming sound less metallic than that due to Cause 5.

Remedy.—Slope or chamfer the ends of the pole pieces so that each armature tooth does not pass the edge of the pole piece all at once. Decrease the magnetization of the fields. Increase the cross-section or magnetic capacity of the teeth, or reduce that of the body of the armature. But these are nearly all matters of first construction, and are made right by good manufacturers.

Cause 9.—Humming due to alternating or pulsating current.

Symptom.—This gives a sound similar to that in the preceding case. It can be distinguished, by determining whether the note given out corresponds to the number of alternations, or to the number of armature teeth passing per second. Usually the latter is considerably greater than the former. This trouble is naturally confined to alternating-current apparatus. The slight pulsations occurring on direct-current circuits due to the commutator are hardly sufficient to produce an audible sound except in a telephone. (See "Heating of Field Magnets," Cause 2.)

Remedy.—It is practically inherent in alternating apparatus, but its effects can be reduced by mounting the machine so as to deaden the sound as much as possible.

Note.—It often happens that a generator or motor seems to make a noise that in reality is caused by the engine or other machine with which it is connected. Careful listening with the ear close to the different parts will show exactly where the noise originates. A very sensitive way to locate a noise or vibration is to hold a short stick or pencil by one end between the teeth and press the other end squarely against the several parts, to ascertain which particular one gives the greatest vibration.

Principles of Electrical Apparatus

THE SYNCHRONOUS MOTOR.—PHASE RELATIONS.

If there were no armature reaction and the armature circuit were not self-inductive, the current taken by a synchronous motor would always be in phase with its e.m.f. and the counter e.m.f. generated by

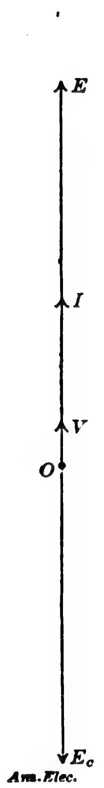


FIG. 1.

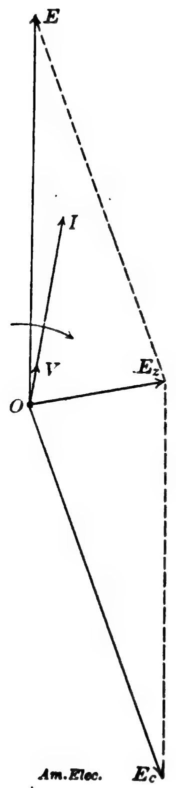


FIG. 3.

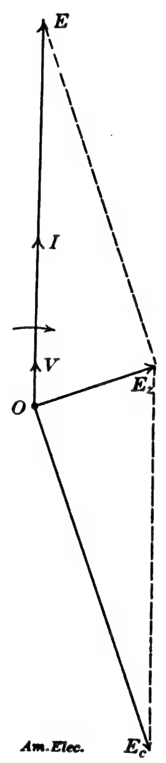


FIG. 4.

the armature would be squarely opposed to the impressed e.m.f. Such an ideal state is represented vectorially by Fig. 1, where *O-E* represents the phase and relative value of the impressed e.m.f.; *O-V*, the phase and value of the e.m.f. expended

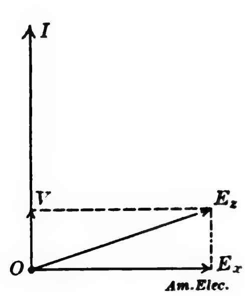


FIG. 2.

in the winding in forcing current through its resistance, and *O-E_c* the phase and value of the counter e.m.f. of the armature. Under such a condition the counter e.m.f. is evidently equal to the impressed e.m.f. minus the resistance drop in volts.

However, the armature of a synchronous motor exerts a most vigorous reaction upon the magnetic flux of the field magnet. And, like any other magnetic body encircled by conductors which are traversed by alternating current, it is highly self-inductive; consequently, if an alternating current be passed through the winding it will lag behind its e.m.f. by reason of the reactance of the armature, whether the armature be rotating or at rest. The component of the impressed e.m.f. which is consumed by the resistance of the winding will be in phase with the current, of course, as indicated by the arrow-head, *V*, Fig. 2. The self-induced or reactance e.m.f. lags 90° behind the current, so that the component of the impressed e.m.f. which counterbalances this reactance e.m.f. must lie 90° *ahead* of the current as indicated by the vector, *O-E_x*. The resultant of the e.m.f's expended in overcoming resistance and neutralizing reactance is obtained by the usual parallelogram method; the vector, *O-E* , represents this.

Now the only other e.m.f. that opposes the impressed e.m.f. is the counter e.m.f. generated by the rotation of the armature in the magnetic field exactly as in the case of a generator The value of this counter e.m.f. depends entirely upon the strength of the field excitation, as in a direct-current machine; but, unlike a direct-current motor, the field excitation and, consequently, the counter e.m.f., do not affect the speed of the machine, because, as explained last month, the speed must have an absolutely fixed ratio to the frequency of the supply current, and cannot vary unless that frequency varies. The result is that altering the field excitation of a synchronous motor not only alters the value of its counter e.m.f. but shifts the phase of that e.m.f., as will be evident presently.

The vector sum of the counter e.m.f. and the impedance e.m.f. ($E^\bullet$) equals the impressed e.m.f. These two e.m.f's are combined by the parallelogram method, exactly as in the previous case. Fig. 3 is a diagram showing the combination of the impedance e.m.f., E_c, with the counter e.m.f., E_c, to give a resultant equal to the impressed e.m.f., *E*. The curved arrow which crosses the impressed e.m.f. and armature current vectors indicates the direction in which the figure is supposed to be revolving. In the case here shown the field excitation of the machine has been adjusted so that the counter e.m.f., E_z is precisely equal to the impressed e.m.f., *E*. The diagram shows that in this case the armature current represented by the vector, *O-I*, leads the impressed e.m.f. to a slight extent. Assuming a constant load on the motor, only a slight reduction in the field excitation would be required to reduce the counter e.m.f. sufficiently to allow the current to come precisely in phase with its e.m.f., as indicated in Fig. 4, where all of the constants forming the basis of Fig. 3 have been retained with the exception of the counter e.m.f.

It will be noticed upon very close inspection that the vectors, *O-I*, representing the armature current; *O-V*, representing the resistance drop, and *O-E_z* representing the impedance drop, are all a trifle shorter than in Fig. 3. The explanation of this is that with a constant load the amount of current required is less when that current is in phase with its e.m.f., as represented in Fig. 4, than when there is a difference in phase, as in Fig. 3. The power factor of the motor is equivalent to the cosine of the angle between the two vectors, *O-E* and *O-I*.

If, now, the field excitation be still further reduced, the counter e.m.f. will also be reduced and the current will lag behind the e.m.f., the extent of this lagging being determined by the extent to which the field excitation is reduced. Fig. 5 shows the condition when the field is weakened sufficiently to allow the current to lag 30°, or 1/12 of a cycle. In this case the impressed e.m.f. and load remaining unchanged, the armature current is increased

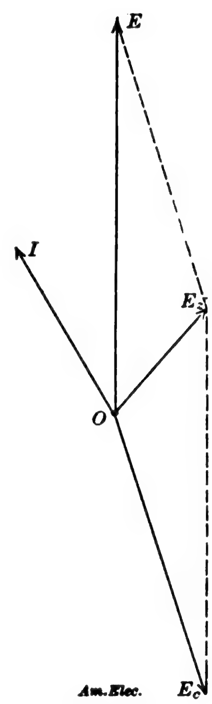


FIG. 5.

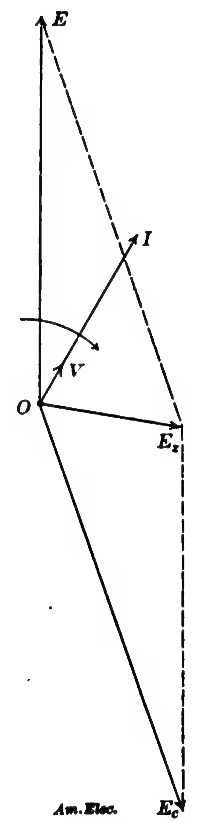


FIG. 6.

considerably, and consequently the resistance drop and impedance drop are also increased, as these vary directly with the armature current.

Fig. 6 represents the phase relations with the counter e.m.f. increased (by strengthening the field excitation) until the current *leads* the e.m.f. 30°; the current strength is precisely the same as when there was a lag of 30° as shown in Fig. 5. It is evident, therefore, that with the load constant, if a certain field excitation allows a lagging current of a certain value to flow, a leading current of precisely the same value can be obtained by strengthening the field excitation; or, in other words, there are two values of excitation which result in the same armature current at a given load, and this is true of every load value within the range of the machine.

Letters on Practical Subjects

Communications intended for publication in this department must be received at this office not later than the 15th of the month prior to the date of publication.

Mr. Brown's Problem in Resistance Connections.

The enclosed diagram (Fig. 1) is submitted as a solution of Mr. Brown's problem in switch and resistance connections of last month. The double-throw switch is represented by *D* and the single-throw

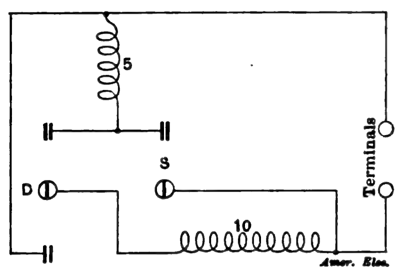


FIG. 1.—MR. BASS'S SOLUTION.

switch by *S;* the main-line connection is at *E.* Throwing the switch *D* upward and closing *S* puts the resistances in parallel and gives 3.333 ohms; closing *S* alone gives 5 ohms; closing *D* downward with *S* open gives 10 ohms and closing it upward gives 15 ohms.

Farmington, Ill. THEO. BASS.

[Exactly the same solution was supplied by Messrs. Frank W. Bone, of Reading, Mich.; F. S. Brewer, of Newark, N. J.; G. D'Eustachio, of Pittsburg, Pa.; F. R. Fishback, of Cleveland, Ohio; R. E. Gibbs, of Springfield, Wis.; F. W. Harris, of Wilkinsburg, Pa.; F. G. Hartwell, of Boston, Mass.; Frank Johnson, of Detroit, Mich.; Wm. Merrill, of Wilmington, Del.; A. Nelson, of Chicago, and Wm. O'Dwyer, of Detroit, Mich.—EDITOR.]

One solution of Mr. Brown's problem in connections is shown by the accompanying diagram (Fig. 2). Closing *S* alone obvi-

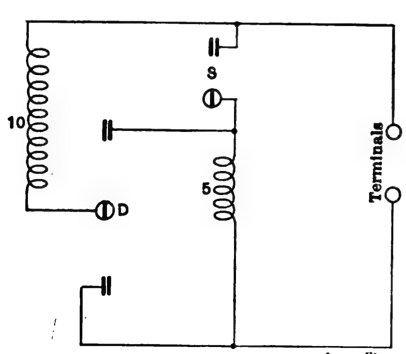


FIG. 2.—MR. SOUTHERLAND'S SOLUTION.

ously puts the 5-ohm coil in circuit; closing *D* downward with *S* open puts the 10-ohm coil in alone; closing *D* downward with *S* closed puts the coils in parallel and closing *D* upward with *S* open puts them in series. Arrangements such as this are frequently used in laboratory work.

Ithaca, N. Y. F. J. SOUTHERLAND.

[The same solution was furnished by Mr. James B. Dillon, of Louisville, Ky. It is like Fig. 1 so far as connections are concerned, the only difference being in the "lay-out" of the diagram.—EDITOR.]

Referring to Mr. Brown's problem in resistance and switch connections, I would

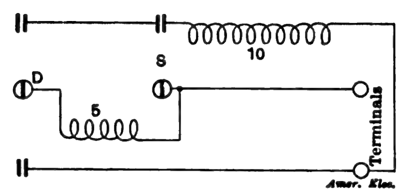


FIG. 3.—MR. GORILLA'S SOLUTION.

suggest the arrangement shown by the enclosed sketch (Fig. 3). If the single-throw switch, *S,* be closed alone it puts the 10-ohm coil in circuit with the main terminals; closing *D* downward alone puts in the 5-ohm coil; closing *S* and throwing *D* downward puts the two coils in parallel, and closing *D* upward alone puts them in series.

Ironwood, Mich. LOUIS J. GORILLA.

[The same solution was sent in by Messrs. John A. Kick, of Marietta, Ohio; A. W.

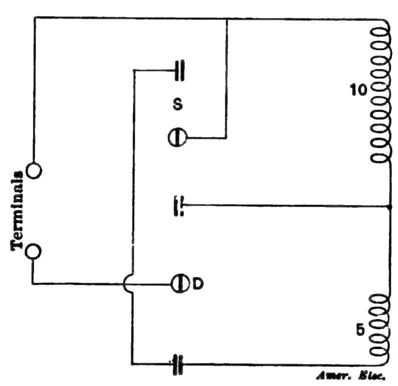


FIG. 4.—MR. RAINE'S SOLUTION.

Lawrence, of Flushing, N. Y.; E. S. Lincoln, of Brookline, Mass.; Geo. C. Ohlin, of South Omaha, Neb.; Gordon Weaver, of State College, Pa., and F. W. Cerny, Mesa, Ariz.—EDITOR.]

The enclosed arrangement of switches (Fig. 4) is submitted as a solution of Mr. Brown's problem last month. The two switches are mounted so that the blade of the single-throw switch, *S,* can be set into the jaws at one end of the double-throw switch, *D.* Closing both *D* and *S* upward puts the coils in parallel and gives 3⅓ ohms; then if *S* be opened, it leaves the 10-ohm coil connected to the main terminals alone; closing *D* downward puts the coils in series, and closing both switches downward puts the 5-ohm coil in alone.

Brooklyn, N. Y. CHAS. W. RAINE.

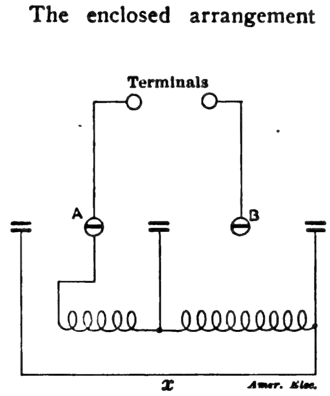


FIG. 5.—MR. STINSON'S SOLUTION.

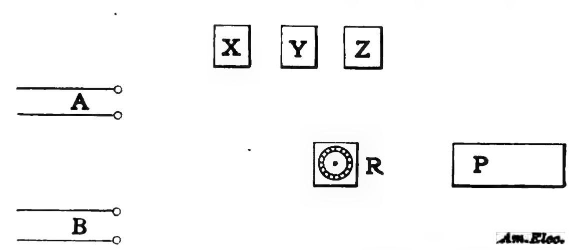
I suggest the accompanying diagram (Fig. 5) as a solution of Mr. Brown's problem in resistance connections. Two double-throw switch blades are mounted so that both of them align with the middle pair of jaws, only three pairs being used instead of the usual four. With both blades to the left, the coils are in parallel, giving 3⅓ ohms; with *A* open and *B* to the left, the available resistance is 5 ohms; with both blades to the right, 10 ohms are available, and with *B* to the right and *A* open, the coils are in series, giving 15 ohms.

West Baden, Ind. C. D. STINSON.

[Mr. Stinson's solution is open to the objection that with *A* closed to the left and *B* to the right the terminals would be short-circuited. Unpleasant results due to this accidental mishandling of the switches could easily be avoided, however, by inserting a suitable fuse in the cross-connecting wire, *x.*—EDITOR.]

Storage Battery Connections.

I submit herewith a problem in storage battery connections which may be of some interest to some of your readers. There are two supply circuits, *A* and *B* (see diagram) of different voltages for charging the portable cells, *P.* A regulating rheostat, *R,* is in series with either circuit and the portable cells, *P.* At certain times only a few portable cells are to be charged, and three other large capacity cells, *X, Y* and *Z,* are used to make up the proper voltage for the charging current. The circuits must be so arranged that either one, two or three of the large cells can be placed in series with the portable cells and the charging current. A switch is to be provided so that when the three large cells are charged their current can be turned into one or two of the portable cells through the regulating resistance, *R.* The large capacity cells are all the same size, also the portable cells.



PROBLEM IN STORAGE BATTERY CONNECTIONS.

If one of the large capacity cells becomes charged more than the other two the connections for discharging it need not be shown. These cells are to be cut out when enough portable cells are charging to ob-

tain the proper voltage. Only common switches are to be used and as few of them as possible.

BROOKLINE, MASS. E. S. LINCOLN.

A Bell and Relay Problem.

In a large building are distributed 15 vibrating bells and 18 push buttons. In the office is a shutter relay and two 32-c.p. incandescent lamps. Current to operate the relay and bells and to light the lamps is taken from a 110-volt circuit, but the full circuit voltage is not applied to the terminals of the bells for obvious reasons. It is desired to connect up the bells, push buttons, relay and lamps in such manner that when the shutter is raised the lamps will light and all of the bells will ring; this condition continues until one of the push buttons (any one of the 18) is pressed, which drops the shutter and extinguishes the lamps. The dropping of the shutter, of course, stops the ringing of the bells. No specially arranged bells are allowable; all of them must be the ordinary vibrating kind. I should like for readers of this paper to suggest the proper method of connecting up the apparatus to obtain the results described.

Washington, D. C. CHAS. W. PETRY.

Mr. Hardwick's Window Lamps.

The accompanying diagram (Fig. 1) solves the problem presented by Mr. Hardwick last month, if we disregard a slight inconsistency in his statement of the proposition. He says that "normally every lamp in the two windows is turned on by each switch," and further on he says that "nothing unusual was noticed until plug No. 4 burned out." This would indicate that all the lamps were controllable by either switch before the plug burned out. But, "with plug 2 out and the rest in, *A* operates half the lights and does not change them." The conditions would surely be the same if *B* were left open and the plug 2 either in or out; therefore, it is evident that with all the fuses in and in proper condition, if *B* were open only half the lamps could be lighted by closing *A*.

By tracing the connections of the diagram and comparing with Mr. Hardwick's list of results obtained under the different conditions of fuses and switches mentioned in his letter they will be found to agree.

Reading, Mich. FRANK W. BONE.

[In justice to Mr. Hardwick it should be explained that his original letter read "every *other* lamp in the two windows," etc. By some unfortunate mischance the word "other" disappeared in the printing office.—EDITOR.]

Mr. Hardwick's faulty connections were no doubt as shown by the enclosed diagram (Fig. 1), which gives all of the combinations he mentions. The error was due to the attempt to use a common return from each window. Fig. 2 shows the proper method of wiring the lamps. With this arrangement the fuses will protect the circuits without giving rise to puzzling combinations.

Newark, N. J. F. S. BREWER.

[Messrs. Bone and Brewer having furnished identical solutions, the one diagram (Fig. 1) has been used for both. The solution agrees exactly with Mr. Hardwick's diagram, which was sent in with his letter. —EDITOR.]

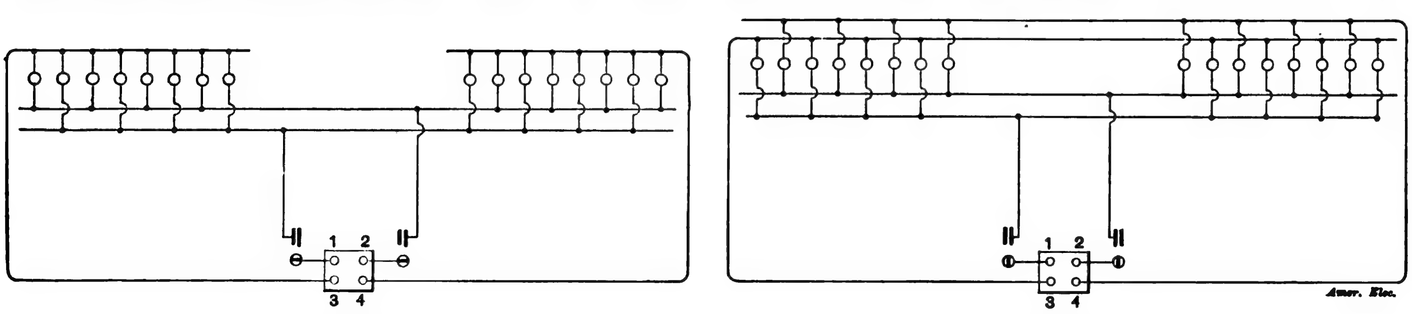
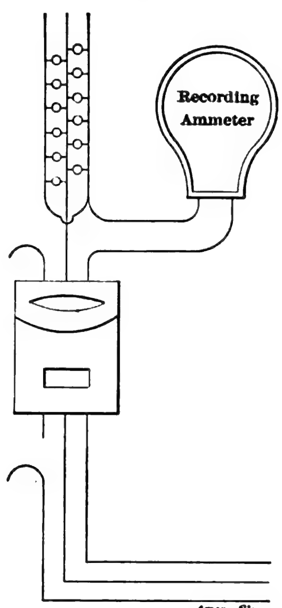


FIG. 1.—SOLUTIONS TO MR. HARDWICK'S PROBLEM IN FAULTY CONNECTIONS.—FIG. 2.

Mr. Vogel's Excessive Current Consumption.

I was surprised not to find in the April number any solution of my excessive meter bill problem, and submit herewith some additional facts, which I hope will be of interest. The company made a test for one week with a Bristol recording ammeter, and under this test the bill amounted to $4.68. At this rate the bill for the month would have been about $18, but the bill rendered was for $28. During the week of the test, the system was connected up two-wire fashion temporarily, as shown by the accompanying sketch. This appears to show that with the two-wire arrangement less current is used than with the three-wire. I should appreciate very much any suggestions that readers of this paper may make regarding the discrepancy.



EXCESSIVE CURRENT CONSUMPTION.

Philadelphia, Pa. J. C. VOGEL.

[It is hoped that Mr. Vogel's peculiar experience will incite some of our readers to an analysis of it. We may say, however, that an ammeter is a poor criterion of power consumption. Meter bills are for kilowatt-hours, not ampere-hours, and though the voltage may not vary greatly, it does not necessarily average up at the value assumed in computing power from the reading of a recording ammeter.—EDITOR.]

Another Telephone Problem.

There are three ordinary bridging telephone sets on a metallic circuit, and it is desired to add standard switches connected up so that any one of the three stations can ring up either one of the other two alone; in other words, the signaling part of the equipment is to be changed from party-line bridging to selective ringing merely by adding switches of regular construction and the necessary connections. The ground may be used as part of the signaling circuits, but not for talking. I should like the readers of the AMERICAN ELECTRICIAN to suggest solutions of the problem.

Helena, Ark. R. N. TURNER.

Switch Connections for Dimming Stage Lights.

Some years ago I had occasion to provide means for dimming an equipment of stage footlights, and having no rheostat handy, I had to figure out some method of quick manipulation by which the lamps could be connected either in parallel for ordinary illumination or in two groups in series with each other for dimming. The arrangement shown by the enclosed sketch (Fig. 1) was adopted, and it has given the best of satisfaction in the place where it was first installed, as well as in many other theatres where I have used it since that

time. Used in connection with a dimmer rheostat it provides a given range of con-

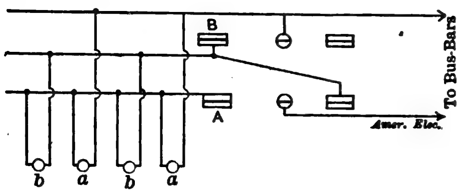


FIG. 1.—STAGE LIGHT CONNECTIONS.

trol with much less resistance in the dimmer than would be required otherwise. By making the jaws *A* longer than the jaws *B*, the lamps, *a*, *a*, can be kept lighted while the other lamps are extinguished.

Paragould, Ark. Thos. G. Van Sant.

[Fig. 2 shows a very similar arrangement which has been used for the purpose described by Mr. Van Sant, and also for testroom work. It consists of a double-throw, double-pole switch, to which are added a single pair of jaws and a corresponding extension of one blade. The only advantage

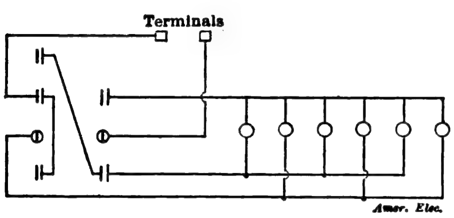
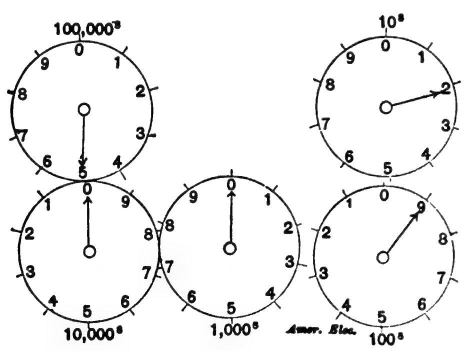


FIG. 2.—STAGE LIGHT CONNECTIONS.

over the arrangement of Fig. 1 is that when the switch is open the distributing wires are all "dead."—Editor.]

Another Meter Reading Problem.

I have been interested in the tricky meter readings which have been published in this department, and recently struck the one shown by the accompanying diagram. I sub-



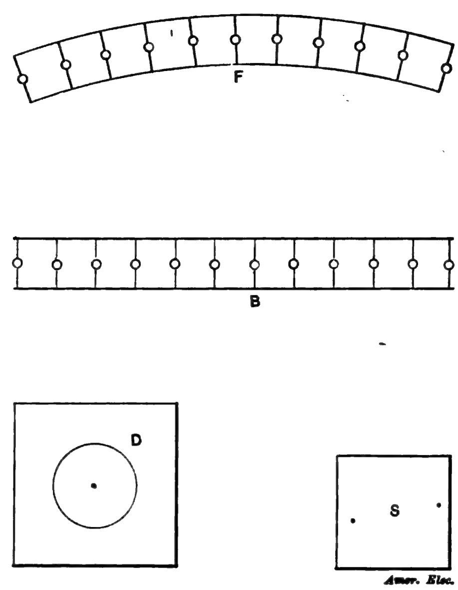
TRICKY METER READING.

mit it for the consideration of other readers.

Greensburg, Pa. Wm. W. Deighmiller.

Problem in Stage Light Connections.

Perhaps the accompanying problem will be of interest to other readers: I had it to solve some time ago. The group of circles, *F*, represents the footlights of a stage; the group *B*, the border lights; the box, *D*, is a dimmer, and the square, *S*, one or more switches of standard construction. The problem is to connect up these so that either group of lamps can be thrown either di-



MR. CONVERSE'S PROBLEM IN STAGE LIGHTING.

rectly on the supply main or through the dimmer, and both groups can be similarly controlled together; in other words, so that either or both groups of lamps can be burned at full candle-power or dimmed, separately or simultaneously.

Chicago, Ill. J. D. Converse.

An Induction Motor Trouble.

Some time ago I installed a 40-h.p. three-phase induction motor on a 60-cycle circuit, with a compensator for starting, the rotor being of the squirrel-cage type. Recently it refused to start up, even with the belt off. I tested the outside connections carefully, found them all right, and dismantled the motor. The rotor bars were solidly connected, and the stator winding tested out absolutely clear and symmetrical. With the current off, the rotor turned freely in the bearings, and the latter were not worn a particle—at least, not enough to be measurable. Putting it back together, it simply hummed and stood still. Finding it impossible to get the machine to run, it was returned to the builders, who supplied another one in its place after subjecting the obstreperous one to every test possible. Very recently I had exactly the same experience with a 50-h.p. machine of the same type. I have not been able to learn what the trouble was with either of them, and would appreciate it if some of your more experienced readers could suggest an explanation.

Brantford, Ont. A. C. Lyons.

Mr. Clarke's Station Trouble.

Noticing that no explanations were offered in last month's paper as to the cause of the trouble described by Mr. L. R. Clarke in the March number, I submit the following suggestions:

Mr. Clarke says he cannot load the 90-kw. generator without its dragging (that is just what it is doing). If he will increase the speed at the engine governor of the 90-kw. machine until it takes its proportional part of the load, and then strengthen the field current until he gets the smallest amount of idle current possible, this trouble will be corrected. The reason the distant station takes more load when the load comes on the railway generator is that the speed at the main station drops and the 90-kw. machine picks up the load. The speed of the exciter has nothing to do with it, provided it will generate the required voltage and supply the requisite exciting current.

Mr. Clarke does not say what kind of governors are used at the two stations, which is very important. Each station should have a very sensitive governor if the stations are to take proportionate parts of the load, otherwise the idle current and power factor will be changed so often that the power from each station cannot be recorded by the ammeter.

South Windham, Me. B. H. Elkins.

Mr. Shadbolt's Telephone Difficulty.

Referring to W. H. Shadbolt's telephone difficulty, which appears in the April issue of the American Electrician, I submit the following explanation, which is simply an example of the application of Ohm's law. Assume, for the sake of clearness, that we have a circuit of twenty telephones, all in perfect working order, that the line has no resistance whatever, and that it requires one ampere to ring each bell, each bell having a resistance of twenty ohms. It is evident that by Ohm's law the drop across one bell will be 20 volts ($E = I \times R$, or $E = 1 \times 20 = 20$).

Now, assume that the generator in use is just capable of giving twenty amperes at a pressure of twenty volts. From the above it is clear that the resistance across the whole line will be one ohm (all bells being connected in parallel).

Now, suppose that, in consequence of the poor ground established by the rods driven into sandy loam, and by the ground being frozen, we have an additional resistance, at the particular stations, where the trouble occurs, of two ohms each. When we ring up from either of these stations there is an outside resistance to ring through of 3 1-19 ohms, instead of one, and this will allow

only $\frac{20}{3\,1/19} = 6\,16/29$ amperes to pass into

the outside circuit. Since it would require 20 amperes to ring all the bells, and there are only 6 16/29 amperes flowing in the circuit, it is perfectly clear why the bells will not ring.

On the other hand, if one tries to ring up from one of the other stations, having, as assumed before, a ground of no resistance, when the current reaches any of the trouble stations it will have a resistance of 22 ohms

to pass, and with a pressure of 20 volts a current of 10/11 ampere would be allowed to flow. This current being so close to the required amount, would, without a doubt, ring the bells. The values which I have used are, of course, not those required in actual service, but I assumed them simply to make the explanation clearer.

W. H. MIDDLETON, JR.
Prince Bay, N. Y.

I beg to offer the following solution of the telephone problem stated by Mr. Shadbolt in your April issue:

Suppose, for convenience, that but one telephone of the twenty on the line has a ground rod driven in dry, sandy soil, and call it the "A" telephone. The other 19 telephones with ground connections to well pipes may be designated as "B" telephones. A good 1600-ohm polarized telephone ringer will operate with not less than 15 volts at its terminals, and this gives a current of $\frac{15}{1600} = 0.0094$ ampere. This means that a 1600-ohm ringer requires at least 0.0094 ampere to operate it. An ordinary telephone hand generator when turned at the usual rate generates approximately 75 volts. Neglecting line resistance, there is a pressure of 75 volts across the "A" telephone when one of the "B" telephones is signaling, and this voltage will send 0.0094 ampere through $\frac{75}{0.0094} = 7978$ ohms; $7978 - 1600 = 6378$, which means that the earth connection at the "A" telephone may present a resistance as high as 6378 ohms and still pass enough current to ring the "A" bell, thus accounting for the fact that the "B" telephones can ring the "A" bell.

Since each 1600-ohm ringer requires to operate it at least 0.0094 ampere, each generator must give out to the line at least $19 \times 0.0094 = 0.1786$ ampere in order to ring the other 19 bells satisfactorily. Suppose the earth connection at the "A" telephone had a resistance of 6378 ohms, the maximum resistance which would permit the "A" bell to be rung. Then, even ignoring the generator resistance, the 75 volts of the ringer would send out only $\frac{75}{6378} = 0.0117$ ampere to the line, instead of the 0.1786 ampere necessary to ring all of the bells of the "B" telephones. This makes clear the failure of the "A" telephone to ring the "B" bells.

Cleveland, O. R. S. MUELLER.

In regard to the telephone difficulty of W. H. Shadbolt, as printed in the April number, I submit the following explanation: In the first place, we know that dry sand, and also dry ice, are non-conductors. Hence in winter we can count on no grounding surface above the frost line. As moist sand is a poor conductor, the amount of surface connection between the conductor and the sand governs the amount of current which can be passed from the rod, so when we cut off the surface above the frost-line, and allow for the gradual drying of the soil below, during the winter, we find the difficulty is simply a lack of surface connection. For proof of this statement take an ordinary battery jar, fill it with moist sand, insert two battery zincs some distance apart, connect these in series with a generator and try passing current through the sand under different loads. To regulate the surface connection, slightly withdraw the zincs. The sand acts similar to a water rheostat. A connection which will ring one bell apparently as well as ever and which is sufficient for conversation will not necessarily ring nineteen times as many in parallel. Where it is inconvenient to obtain a connection with permanent moisture, as in the case of the well pipes, if the grounded conductors are soldered to buried copper plates much less difficulty will be experienced.

Mapleton, Conn. RALPH E. SPAULDING.

Mr. Shadbolt's trouble is due merely to the fact that his ground connections are poor, so that while the ringing and talking current from any one station to the main station may be sufficient, the ground resistance is too high to permit sufficient current to flow from the main station to all of the others in parallel.

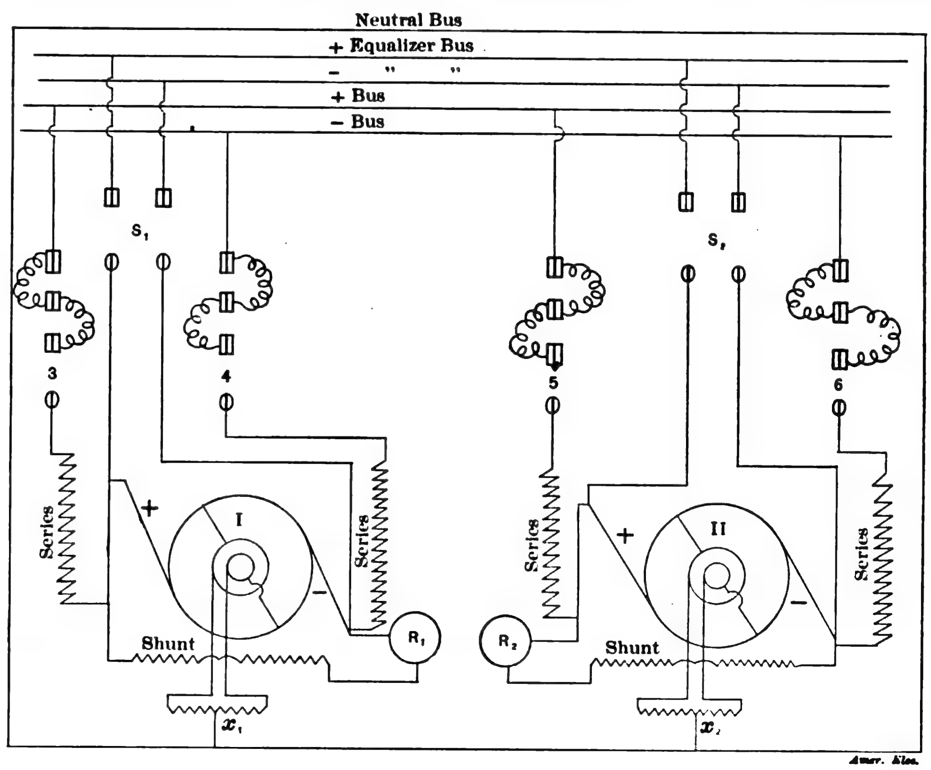
West Baden, Ind. C. D. STINSON.

Three-Wire Generators in Parallel.

Enclosed please find a somewhat tardy solution of Mr. Malcolm's problem in "Connecting Three-Wire Generators in Parallel," which appeared in the November (1904) number of your paper, and escaped my attention until recently. Referring to the diagram of connections, I and II are the three-wire generators, and X^1 and X^2 are the alternating-current compensators connected with the neutral bus-bar as shown. The equalizer switches, S^1 and S^2, of the machines 1 and 2, respectively, are double-pole switches, while switches 3, 4, 5 and 6 are single-pole switches of the style used in the field circuit of an alternator, resistance coils being connected between the stationary parts of each switch. When one generator is operating and it is desired to run the other in parallel with it, the voltage and speed of the incoming machine are properly adjusted, and its equalizer switch is then closed, as usual. The main switches, 3 and 4 or 5 and 6, as the case may be, are then put on together and slowly. None of the measuring instruments are shown, but it is an easy matter for any one to connect them in. The shunt winding is connected across the brushes, a short shunt.

I trust the solution is not too late for consideration.

Brookline, Mass. E. S. LINCOLN.



THREE-WIRE GENERATORS IN PARALLEL.

Faulty Generator Connections.

A peculiar occurrence, which took place recently at the Cudahy Packing Company's plant, Kansas City, Kan., may bear relating. The plant consisted of one 200-kw. Crocker-Wheeler machine and one 350-kw. machine, but owing to increasing demand for power a new 300-kw. was purchased. Space being limited in the engine room it was found necessary to move the switchboard and also on account of high water to raise it 15 feet. Accordingly, work was commenced early one Sunday morning with the intention of finishing before dark. The switchboard is a five-panel slate board, with

eight power circuits and two lighting circuits, each protected by circuit-breakers. The generators are 250-volt, compound-wound machines operated in parallel and connected by the usual equalizer. When everything was declared ready, the larger machine was started, but contrary to expectations it failed to pick up.

A thorough search was instituted at once, a magneto and bad language being freely used. It was discovered that the equalizer and series leads were crossed, but when these were set aright only 3 or 4 volts resulted. The small machine was then tried and proved all right. After another examination the lead wire coming from the generator field winding was found to be connected to the same bus-bar as was the jumper on the generator terminal board. Correcting this proved of no avail, and separate excitation was then resorted to, which had the desired effect. This should have been a hint of impending trouble.

The voltages were equalized and the machines thrown together; there ensued a flash, the 200-kw. circuit-breaker opened, and the load was all thrown on the larger machine. Carefully adjusting their voltages it was again tried, with the same results. Apparently one machine had been reversed, and the large machine was selected as the one by observing the light thrown by the arc lamps. The field wire leading to the board and one of the voltmeter wires were soldered together, and when this was changed it reversed the voltmeter connection. Then the series and armature leads were changed, also the field and voltmeter wire, and conditions brought back to normal. Had the leads been properly tagged before disconnecting, all trouble would have been obviated. Owing to the fact that they had to be lengthened and shifted around two or three times in cramped quarters, mistakes were easy.

These are the amphibious machines spoken of in the September, 1904, issue of the American Electrician, having passed through two floods, both of several days' duration. They are to-day apparently as good as new.

Kansas City, Mo. C. E. Bryson.

Water Tank Gauge.

When water storage tanks of about 5000 gallons capacity are located one hundred feet or more overhead it is not a very easy matter to keep accurately informed as to the depth of water on hand. When the tank is not very high and located so that the engineer can readily see it, a float with cord attached, operating on a scale outside of the tank is satisfactory; but when the tank is 150 feet or 300 feet, as in the case of the Deering Harvester Works, this arrangement is quite impracticable. The sketch herewith shows an arrangement made use of to enable an engineer to tell directly from the engine room, the height of water in a tank. A ¼-inch pipe is run from the tank to the ground and then continued about a foot underground to the engine room, where it connects with the mercury gauge shown to larger scale by Fig. 2. A piece of 2-inch pipe about four feet long plugged at both ends has one end connected to the ¼-inch pipe from the tank while the other end is connected with the vertical pipe as shown. The upper end of this vertical pipe is connected to a glass gauge 18 inches long, one end being open to the air. Through a small plug in the top of the reservoir mercury is poured and the valve in the ¼-inch tank connection opened, which forces the mercury up into the glass tube. The principle of the arrangement is evident. Since mercury weighs 13.5 times as much as water, about seven feet is required to balance the 100 feet of water from the tank. The 18 feet of depth in the tank would then vary the column of mercury 15⅜ inches, making a foot in the tank correspond to about ⅞ inch on the scale of the gauge, which is a convenient amount. It should be remembered in making such a gauge that the height of the column in the vertical pipe does not represent the entire mercury pressure, since the height in the reservoir drops slightly as the column rises.

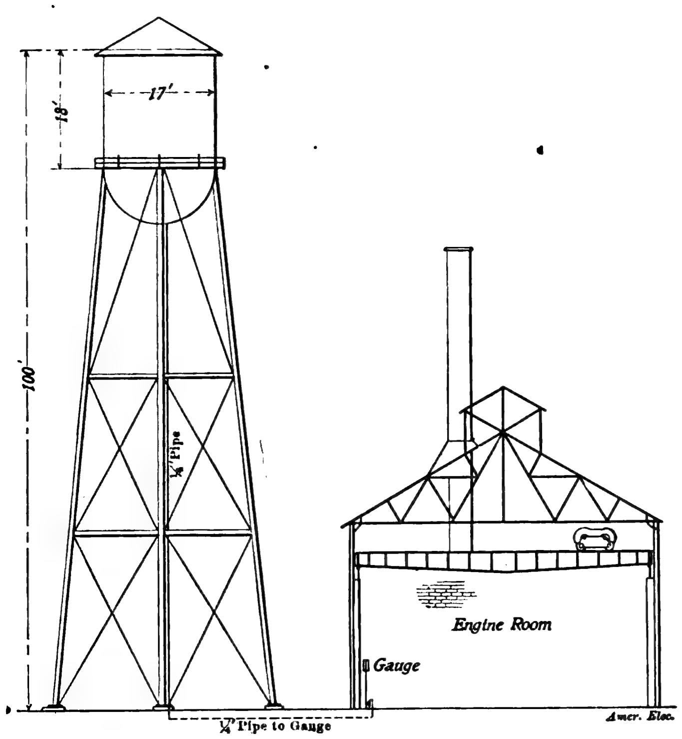


FIG. 1.—WATER TANK AND POWER HOUSE.

If d = depth of tank in feet,

A = area of reservoir,

a = area of vertical pipe in gauge,

s = length of scale in inches, representing d feet,

then in filling the tank from zero to the d point, the mercury in the vertical tube rises s inches, the mercury in the reservoir drops $sa \div A$, giving a total increase of $s + (sa \div A)$, or $s\,(A + a) \div A$. Equating this to the difference of pressure from the tank gives $12\,d \div 13.59 = s\,(A + a) \div A$ and $s = (12\,d \div 13.59) \times [A \div (A + a)]$, or depth of one foot water on gauge scale equals $.8836\,A \div (A + a)$ inches. In this case where the reservoir was 2 inches in diameter and the tube about ¼ inch the ratio of the areas was 1 to 64, consequently the gauge divisions were very nearly .8836 inches.

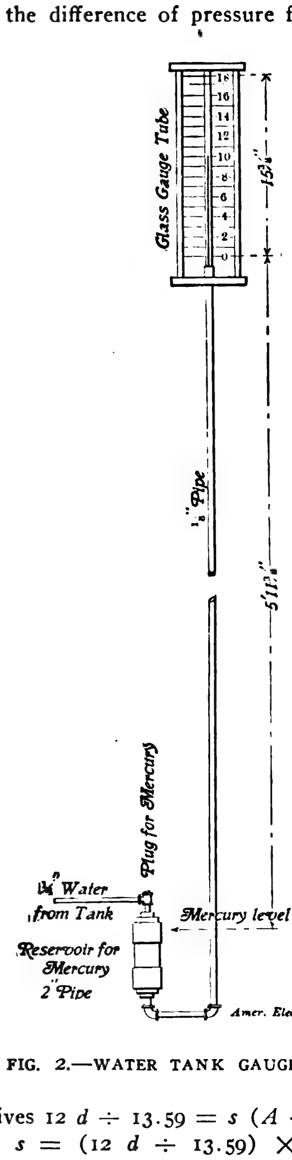


FIG. 2.—WATER TANK GAUGE.

Phoenix, Ariz. John D. Adams.

Questions and Answers

Inquiries not accompanied by the name and address of the inquirer, will not receive attention.

Is the tantalum lamp on the market in this country, and if so, where can it be obtained? H. E. B.

No; it is manufactured in Germany only, and no agency has been established in this country so far as we are aware.

What is the significance of the letter *j* used by Steinmetz in alternating-current calculations? B. C. B.

It is merely an operator to indicate vector addition or subtraction instead of algebraic computation.

Where is the best place to locate the fusible plug in an upright submerged flue boiler? O. F. S.

If you mean the ordinary vertical tubular boiler, the crown sheet is the proper place for the plug.

Where can I obtain the rubber tube specified in "Electrical Designs" for the 6-in. spark coil? C. H.

From any maker of hard rubber, such as the Goodrich Company, at Akron, Ohio, or any large dealer in such goods.

What causes a compound-wound generator to decrease its voltage as the load increases, the load being within the maximum capacity of the machine? H. A. S.

Either the shunt strip across the series field terminals is too short or the series winding is connected up backwards and is opposing instead of assisting the shunt winding.

A small shunt-wound machine wound for battery current runs fairly well as a motor, but will not operate as a dynamo, even at double its normal speed. It has a "polar" armature with 8 coils. What is probably the trouble and what the proper remedy? E. G.

The field winding probably requires more current to excite it fully than the armature is capable of delivering. There is no remedy.

Which is better for transmitting heavy alternating currents, a solid or a stranded conductor? (2) What size should be used for 200 or 250 amperes? S. B. F.

Stranded conductor. (2) That depends largely on the distance and the allowable drop, but under the Fire Insurance Rules rubber-covered conductors carrying 200 amperes must be not smaller than 200,000 circular mils cross-section; for 250 amperes, 300,000 circular mils would be required.

Can I supply 110-volt lamps from a 220-volt direct-current circuit? (2) How can a compound-wound generator be made to increase its compounding effect? J. R. W.

Not without using a dynamotor or a motor-generator between the supply line and the distributing mains. (2) By lengthening the shunt strip across the terminals of the series winding, provided the machine is not operating in parallel with others. If the shunt strip is already at the limit of its adjustment, another one of higher resistance must be substituted.

What is the best construction for an alternating-current magnet? (2) What size and weight of magnet would be necessary to lift 20 pounds? (3) Would the lifting power of an alternating-current magnet be affected if the magnet were located in an iron pipe or casing? S. R.

The core and all other parts of the magnetic circuit must be thoroughly laminated; otherwise, the construction is the same as for direct current. (2) We have no data for such a magnet and cannot undertake to design apparatus. (3) Not if the magnet is of the iron-clad type; otherwise, the magnet would be affected and the iron pipe would probably be heated.

Which of the circuit arrangements shown in Figs. 1 and 2 is preferable for two-station control? J. F. L.

Although Fig. 2 may require more wire, it is usually preferable for the reason that

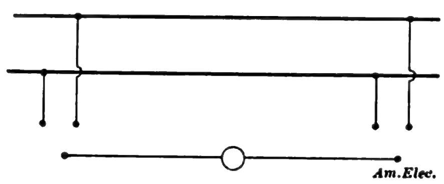


FIG. 1.

it can easily be changed to three or four-station control; Fig. 3 shows the change required to obtain three-station control.

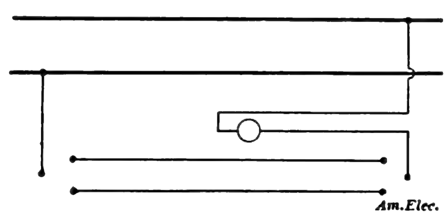


FIG. 2.

Moreover, Fig. 2 is not favored by the Underwriters because both sides of the circuit are carried to the switch.

Why will a direct-current motor start up with the field circuit open when the armature switch is closed? (2) What is the advantage in using six-phase rotaries instead of three-phase? (3) What is the voltage between any two adjacent taps of a six-phase rotary armature? J.

Because the field magnet after once being excited retains a weak magnetic polarity

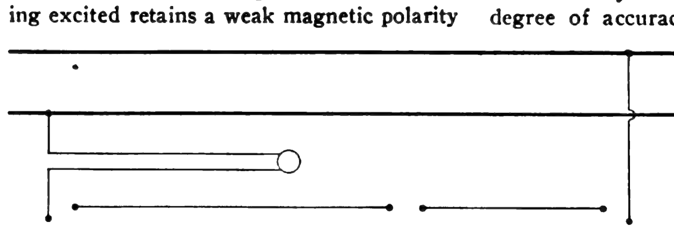


FIG. 3.

commonly known as residual magnetism. (2) Because there is less heating in the armature with a given output. Consequently, a greater output can be obtained from a given armature with the same amount of heating. (3) This depends entirely upon the voltage of the supply circuit. The voltage between any two adjacent taps of the armature is 0.354 of the direct-current voltage at the commutator brushes.

About what is the e.m.f. of a battery cell having copper and zinc elements and an electrolyte of dilute acetic acid or strong vinegar? (2) What is the electrostatic capacity per mile of a single No. 12 iron wire suspended 20 feet above the ground? (3) Can brass spiral springs which have lost their elasticity by being heated be restored? W. H. S.

From 0.2 to 0.3 volt. (2) The formula for capacity in microfarads per mile of length is:

$$\frac{0.0388}{\log \dfrac{4h}{d}},$$

in which h is the height above the ground and d the diameter of the wire in the same units. (3) No.

What is the best arrangement of circuits for supplying ninety series enclosed arc lamps, each requiring 80 volts at the terminals and the supply source being a 2200-volt alternator? (2) Can they be divided into four circuits, two of 22 lamps and two of 23, and the four circuits operated in parallel from the machine, or will the regulator not take up the difference in voltage? W. W.

We should prefer to divide the lamps into three circuits of thirty lamps each and increase the voltage of the machine, if this can be done without interfering with other circuits. If not, it would be better to run three circuits of say 25 lamps each and one circuit of 15 lamps, putting a permanent choking coil in the last circuit to take up most of the difference in voltage. Still another practical way would be to put in a 100-lamp series transformer and put all the lamps on one circuit. (2) Yes, with an independent regulator in each circuit.

What is the area of a circular mil? (2) What is the best formula for calculating the size of wire in a three-wire system? (3) What is the best method of computing the efficiency, required current and proper size of feed wire for a motor? (4) Will a shunt-wound motor run with its field winding open-circuited? G. H. L. R.

0.7854 square mil, or 0.0000007854 square inch. (2) Compute the size of the outside wires as though for a two-wire circuit of the over-all voltage and make the neutral wire the same size for interior work; for outside work make the neutral wire of half the cross-section of each outer wire. (3) The efficiency cannot be calculated with any degree of accuracy; the machine must be tested. The required current is ascertained by multiplying the horse-power by 746, dividing the result by the voltage, and dividing this latter result by the efficiency expressed decimally. For the proper size of feed wire, multiply the distance by the required current and multiply the product by 27; divide this last product by the allowable drop in volts and the result will be the cross-section of the wire in circular mils. The factor 27 includes the 25 per cent excess current for which the Underwriters require provision. (4) If the field magnet has much residual magnetism the armature will probably run at a very high speed without load; it will not carry an appreciable load.

AN AUTOMATIC SYNCHRONIZER.

To start alternators or rotary converters quickly and to bring them from a standstill to full running condition within the briefest possible period is one of the essentials of modern service, and, consequently, the ability to synchronize quickly machines which are to operate in parallel is a matter of importance. Incandescent lamps connected between the incoming machine and those running have been most frequently used in the past to indicate the phase relation by the pulsation of the light. This arrangement does not fulfill the requirements of modern service, however, as the phase difference is only roughly shown and, furthermore, there is no indication whether the incoming machine is running too fast or too slow, the fact of synchronism being indicated by dimming of the lamps, at which time the operator throws the generator switch. Moreover, during the time required to close the switch, the machines are liable to pass the point of synchronism, which would cause the surging of the currents between the machines. The introduction of the synchronism indicator marked a distinct advance in this branch of electrical practice. By its use it is possible to determine not only when there is a phase difference, but its amount, whether the incoming machine is too fast or too slow, and the exact moment when the machines are running synchronously and may be paralleled.

Although the synchroscope was a long stride in advance of the older methods of indicating synchronism, and still has wide general application, it has limitations in service, as it has no value further than visually indicating the conditions of the incoming machine, the throwing in of the switch being dependent on hand operation.

Accordingly, the Westinghouse Electric & Manufacturing Company has brought out an automatic synchronizing apparatus which is illustrated herewith. The apparatus comprises an electromagnetic synchronizer, an electromagnetic relay switch controlled by the synchronizer and a similar switch arranged to connect and disconnect the alternator or converter and controlled by the relay switch. The connections are clearly shown in Fig. 1. Fig. 2 is a view of the synchronizer and relay switch, with the hand switches which control their activity.

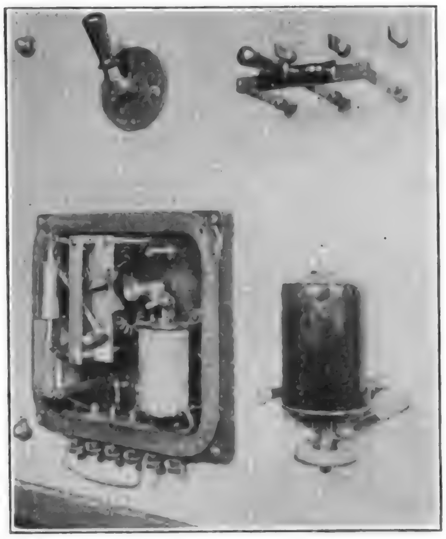


FIG. 2.—SYNCHRONIZER WITH RELAY AND CONTROLLER SWITCHES.

Referring to Fig. 1, the main switch is provided with two actuating coils, one for closing it and the other for tripping it and allowing it to open; presumably it is held closed by a latch and provided with a spring tending to open it when the latch is tripped, like a circuit-breaker. The hand-controlling switch when thrown to the right puts the main switch in condition to be closed by the relay switch; when thrown to the left it energizes the tripping coil and causes the main switch to open. The synchronizer switch merely connects the solenoids of the synchronizer to the potential transformers. One of these takes current from the bus-bars and the other from the incoming machine; when the incoming machine is sufficiently near to synchronism with the bus-bars to allow for the brief time required for the operation of the switches, the synchronizer closes the circuit of the solenoid on the relay switch, and that switch promptly closes the circuit of the closing coil on the main switch, which thereupon connects the incoming machine to the bus-bars. As just intimated, these consecutive operations require a very brief time period, and the synchronizer is calibrated to allow for this, so that when the main switch actually closes the incoming machine will have reached precise synchronism—unless the phase difference is varying too rapidly for successful paralleling, in which case the synchronizer will fail to close the circuit of the relay switch and thereby prevent miscoupling. This is accomplished by means of an ingenious attachment in the synchronizer which withdraws one of its contact brushes when the frequency of the incoming machine differs greatly from that of the active machines; as the difference in frequencies becomes less this device allows the synchronizer contacts to be closed ahead of the instant of synchronism by a margin corresponding to the time element of the magnetic switches.

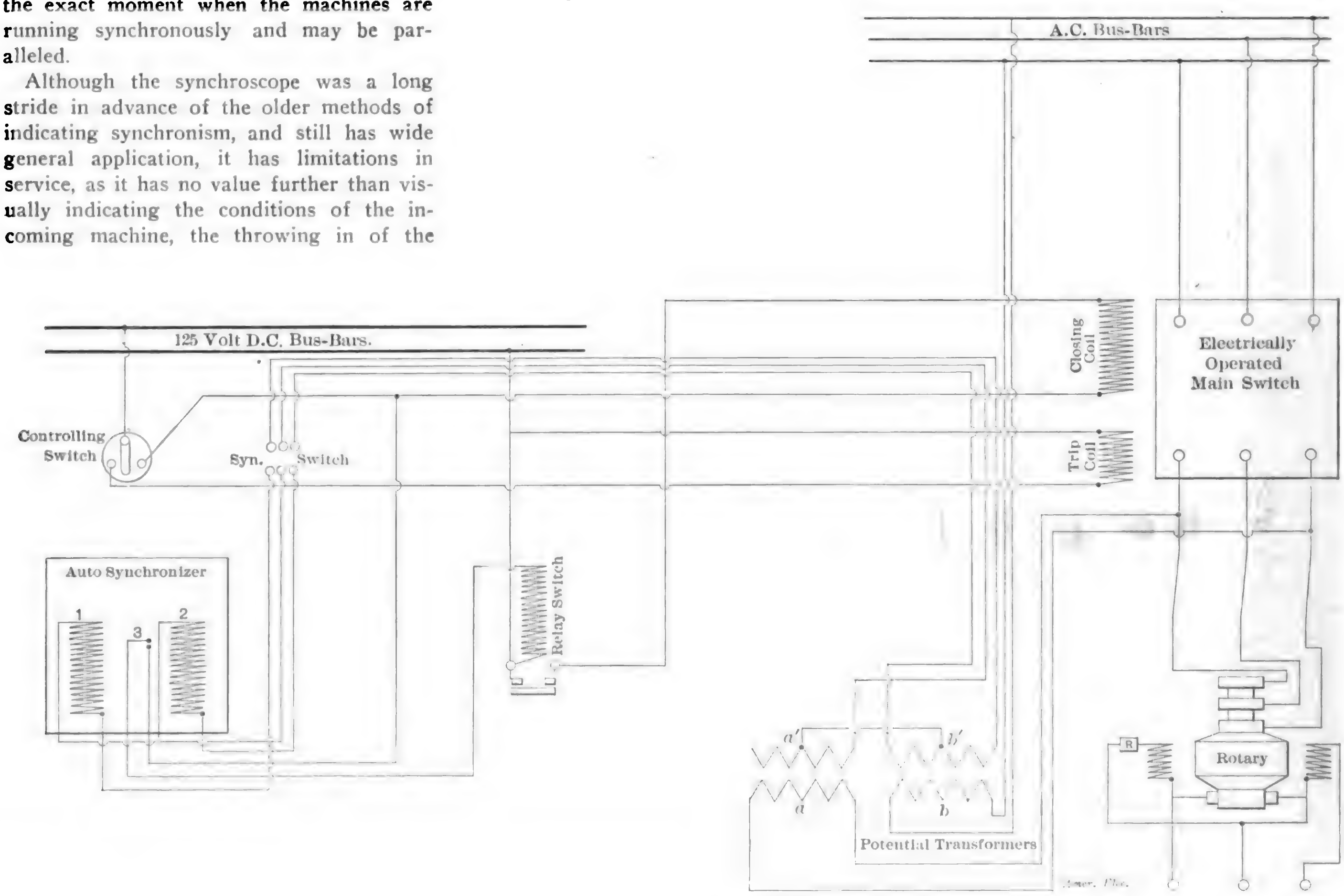


FIG. 1.—DIAGRAM OF CONNECTIONS FOR AUTOMATIC SYNCHRONIZER.

New Apparatus and Appliances

NEW HIGH-DUTY STORAGE BATTERY.

Fig. 2 herewith shows the Bijur high-duty storage battery brought out by the General Storage Battery Company, of New York City. The plates are of the Planté type; but while they retain the well-tried chemical combination of lead and sulphuric acid, they differ radically in design and results from forms hitherto known. Reference to Fig. 1 shows that the plate is made up of multiples of pure lead structures in the shape of gratings. These are welded in a stiff frame made of lead and antimony without the use of any extraneous material whatever. Space is provided at each end of the sub-element for expansion, and the make-up of the sub-element allows for lateral expansion also. During the formation process the oxide formed assumes an elliptical shape, and is said to lock itself securely in the diminutive rectangular cells. The formation, however, is such that a slot is left through the center of the oxide mass, so that the electrolyte can flow freely through it. The advantages claimed from following this mode of construction are, perfect diffusion, absence of deleterious sulphation, blistering or shrinkage and immunity from buckling. The makers maintain that the batteries may be charged with a potential of 2.4 to 2.5 volts instead of the usual 2.7 volts. Twenty per cent. greater capacity is claimed with about 10 per cent. more reserve lead for the same size of plate. Various sizes of plates are, of course, made; but these differ from the one shown only in the number of sub-elements combined, the sub-elements being of the same size in all of the various plates.

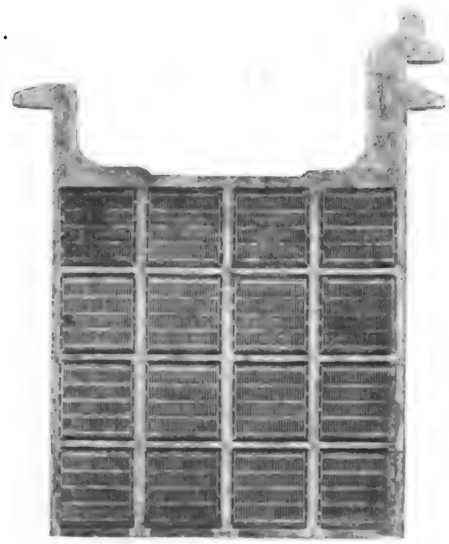
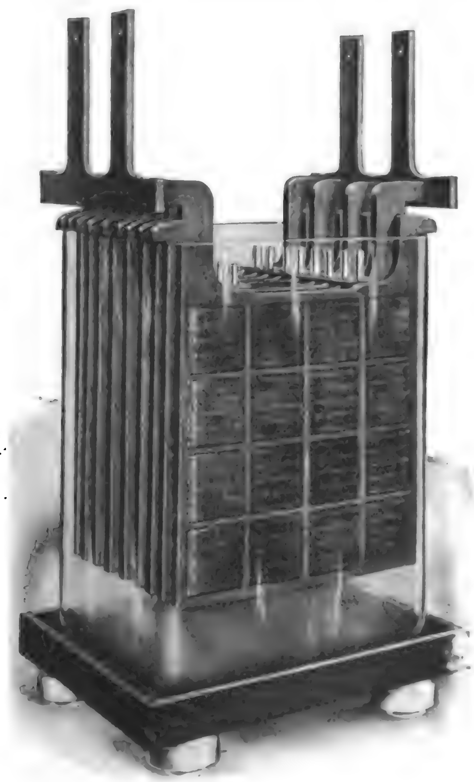


FIG. 1.—BIJUR UNFORMED PLATE.



FG. 2.—BIJUR HIGH-DUTY STORAGE BATTERY.

OUTDOOR OIL SWITCH.

The demand for a serviceable outdoor type of oil switch adapted for use with alternating-current series arc lighting systems, for cutting out banks of transformers, isolating underground or overhead feeders and mains from main systems and operating inductive loads of all kinds, led the Westinghouse Electric & Manufacturing Company to design and place upon the market a switch to meet these requirements. It is a double-pole, single-throw switch, mounted in a weather-proof case, which may be easily attached to poles or cross arms in the case of overhead systems, or may be hung in manholes where underground systems are used. The essential features consist of knife-blade contacts submerged in oil and high insulation between poles and between frame and live parts. Knife-blade contacts are used as they insure the best contact for low temperature rise. Each jaw has a detachable arcing piece which takes the final break, thus preventing any possibility of arcing between the jaws and blades. These arcing pieces may be removed very easily when worn out or burned away. Suitable barriers are placed between the poles, which prevent the arcs from communicating. The switch weighs 40 pounds. When so ordered a special oil may be furnished with this switch which is especially suitable for use in cold weather, as it has a very much lower congealing point than any oil now on the market, which is otherwise suitable for oil switch work. One and one-half gallons are required to fill the tank. The switch has a maximum capacity of 200 amperes at 2300 volts.

FIG. 3.—OIL SWITCH.

SEMI-ENCLOSED MULTIPOLAR MOTORS AND DYNAMOS.

Fig. 4 illustrates one of the very complete lines of multipolar dynamos and motors now being manufactured by Bartz, Wygant & Brown, Hornellsville, N. Y. The field magnet yoke is of cast iron and the magnet cores are of round wrought iron cast-welded into the yoke ring. Pole shoes of cast iron are provided; these, of course, are removable to allow the removal of the magnet coils. The coils are machine-wound and insulated in the usual manner, and the armature coils are also form-wound and individually-insulated. The armature core is of the now conventional slotted type, built up of thin discs which are mounted directly on the shaft. The latter is of unusually large diameter, and therefore extremely stiff and strong; it is made of the best crucible steel. The bearings are of the ring-oiling type, and are provided with glass sight gauges and stop-cock drains. The commutator is of large diameter, built up under heavy pressure and insulated with carefully-gauged mica; the makers state that loose mica and high or low bars are unknown in their commutators. The brush-holders are of the reaction type, carbon brushes being used, of course; the current density at the brush faces is considerably lower than is usual in similar machines, giving a low temperature rise at this point. The dynamos are ordinarily compound-wound and the motors shunt-wound. The construction of the protecting wings on the frame is so clearly shown by the illustration as to require no comment.

FIG. 4.—SEMI-ENCLOSED MOTOR.

THE BARAGWANATH CONDENSER.

Fig. 5 herewith shows a sectional elevation of the Baragwanath condenser manufactured by William Baragwanath & Son, Chicago, Ill. The water is fed in the side of the condensing chamber, which it enters in a thin circular sheet which passes down through the contracted throat with such

velocity as to carry with it the air passing over with the steam and in the condensing water itself. A supply of 1½ gallons per indicated horse-power per minute is said to be ample. The throat is carefully bored its entire length. The water nozzle is adjustable, thereby admitting of close regulation of the water supply while still maintaining the circular form of the stream of water as it enters the condensing chamber, and ex-

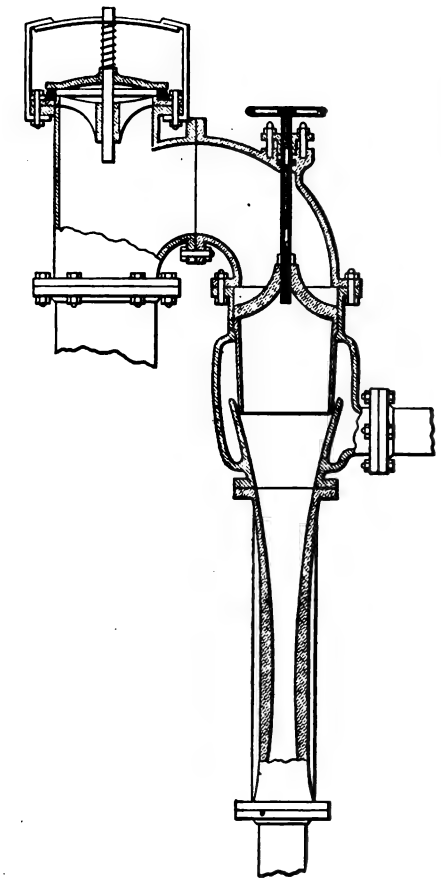


FIG. 5.—SECTIONAL VIEW OF BARAGWANATH CONDENSER.

posing the same large condensing surface. Even when nearly shut off the manufacturers claim there are no bare spots on the side of the condensing chamber, the circular sheet of water simply being thinner. The relief valve seats on a heavy molded rubber gasket, which is readily removable and is cushioned by a spring to take off the jar on the condenser when it lifts. The condenser is applicable to any purpose for which a vacuum is required. It is set at a height of 34 feet above the hot well and clears itself of the discharge water and air by gravity alone. The manufacturers claim that it will secure and maintain a vacuum ranging from 24 to 26 ins. ordinarily, and will syphon its own water safely up to 15 feet as a maximum. Any ordinary type of pump will answer as a supply.

ROCHESTER FAN MOTOR OUTFIT.

The Rochester Electric Motor Company, of Rochester, N. Y., manufacture the fan motor outfit shown by Fig. 6 herewith. The motors in the smaller sizes are bipolar, with magnet poles cast integral with the yoke or frame. In the larger sizes the motors have four poles, the frame being of cast iron and the pole pieces built up of punchings and bolted to the frame. In the bipolar machines the wires are wound directly into the insulated slots, the manufacturer finding that by this means more copper could be placed into the same sized slot than with the former coil. The four-pole machines are form wound. The brush

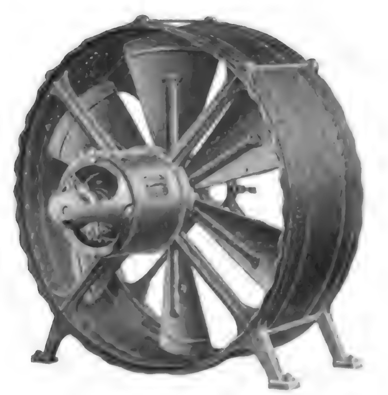


FIG. 6.—ROCHESTER VENTILATING FAN MOTOR.

holders are of the box type, two flat springs in the box providing ample carrying capacity without the use of a copper cable, and since the current density never exceeds 20 amperes to the square inch of brush contact, there is no heating or sparking. Unless otherwise ordered the motors are series wound for 115, 230 or 500 volts. The field magnet coils are wound on forms, heated, dipped into insulating varnish, baked and insulated with mica and tape. The bearings are of phosphor-bronze and flooded with oil by rings of large diameter and a special system of spiral grooving. The bearings are interchangeable for motors of the same size and the oil wells are of ample capacity. The curved blades of the fan have an expanding pitch and may be set to suit the conditions under which the fan is to operate. The shape of the blades is such that the passage of light is unobstructed. Every outfit is rigidly inspected and tested before shipment. The size of fans run from 18 to 96 inches in diameter and the speed from 800 to 2,000 r.p.m. The horse-power of the motors used ranges from ⅛ to 4 horse-power. The capacity ranges from 3,400 cu. ft. of air per minute to 6,300 cu. ft.

IMPROVED MOULDING FOR ELECTRIC WIRES.

The Improved Moulding Manufacturing Company, of Philadelphia, has brought out the type of wooden moulding for electric wires shown by Fig. 7 herewith. This moulding is designed to hold the wires in

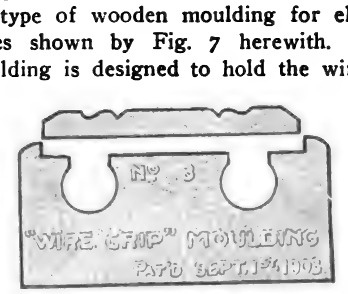


FIG. 7.—END VIEW OF MOULDING.

place without the use of nails or tacks until the capping can be nailed on. As is well known it is next to impossible to hold wires in the grooves of the ordinary moulding on ceilings and keep it there without the use of nails or tacks. The opening in the groove of the moulding shown is made so that the wire may go in easily, while the natural twist or kinkiness of the wire causes it to take such a hold in the groove that it cannot be shaken or hammered out.

ALCOHOL TORCH WITH ADJUSTABLE BLOW-PIPE.

The pocket-size alcohol torch shown by Fig. 8 herewith is made by the H. C. Roberts Electric Supply Company, of Philadelphia, Pa. Its novel feature consists of

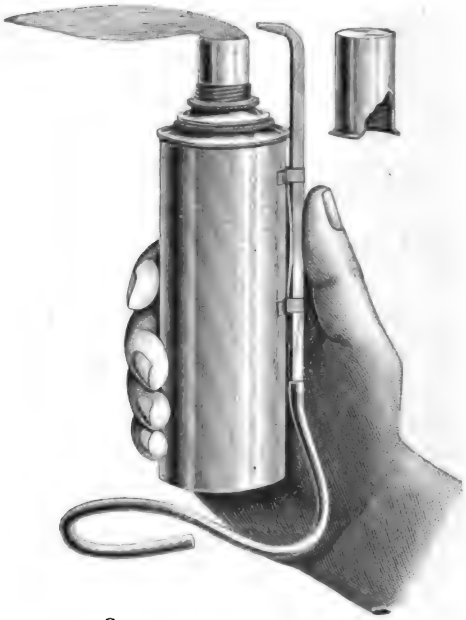


FIG. 8.—ROBERTS ALCOHOL TORCH.

the automatic arrangement for fastening and adjusting the air pipe and nozzle. Between the torch and air pipe a bow spring is inserted, which causes the air pipe to bind against the keepers. A slight pressure of the thumb, as indicated in the engraving, enables the user to adjust the nozzle by an upward or downward movement of the same finger.

ALTERNATING AND DIRECT-CURRENT GENERATORS.

The R. M. Cornwell Company, of Syracuse, N. Y., has recently added to its line of small machines, the "Wonder" alternator, which is a very interesting piece of apparatus. It is very desirable from the fact that all kinds of experiments can be performed that require an alternating current.

FIG. 9.—"WONDER" ALTERNATOR.

It is said to be the smallest alternating-current machine ever offered for sale, and has a laminated armature. All parts are interchangeable, and so arranged that they can be easily taken apart to show the general

construction throughout. The machine is designed for experimental purposes in schools and colleges. It has an output of 12 watts, and is wound for a number of different voltages. When operating the little machine as a generator the alternating current can be taken off one end and direct current from the other. The machine will also operate as a motor on the 110-volt, direct-current circuit, by using a lamp in series.

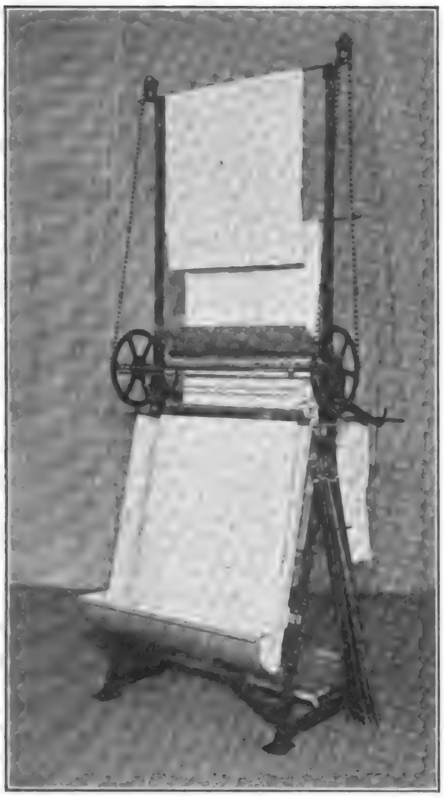


FIG. 10.—BLUE PRINT WASHING AND DRYING MACHINE.

BLUE-PRINT WASHING AND DRYING MACHINE.

The accompanying illustrations show a blue-printing washing and drying machine made by C. F. Pease, of Columbus, Ohio. This machine was designed for the purpose of reducing the cost of producing large quantities of blue prints and to do away with the large washing tanks and drying paraphernalia usually occupying a great deal of space in a blue-printing department. The washing of the prints is accomplished by a spray of running water flowing over the treated side of the paper only, removing the surplus ferro-prussiate in the quickest possible time. Prints are not soaked through as in the old process, as the water coming in contact with one side of the paper only and for but a short time leaves it in a condition to dry in about one-third of the time usually required. The print is placed on the drying rod before washing and remains there during the entire process of washing, wiping and drying. As it hangs in the washing tray on the drying rod, the water flows over the doubled print, half on one side and half on the other. The surplus water is removed by a device which wipes the print as it is moved upward out of the way on the drying chains. As the next print is pulled through the wiping device the previous print is carried still higher up and over the top until it is automatically stripped from the chains of the machine, falling into a drying rack, from which the dry prints may be removed as required. The construction of the machine is clearly shown in the illustrations. The frame is of cast iron thoroughly braced, and supports the washing, dripping and drying devices. The washing tray, guard and pan are made of galvanized iron and reinforced by malleable galvanized-iron fittings. The upper frame carries the small sprockets and chains and is made of iron tubing well braced and secured to the main frame of the machine. Screws are provided for adjusting the chain. The spray comes through brass tubing properly guarded by a copper shield to direct the spray where required. The drying rods are of maple and are provided with rubber separators.

FIG. 12.—MACHINE WITH AUTOMATIC SEPARATING AND DRYING RACK.

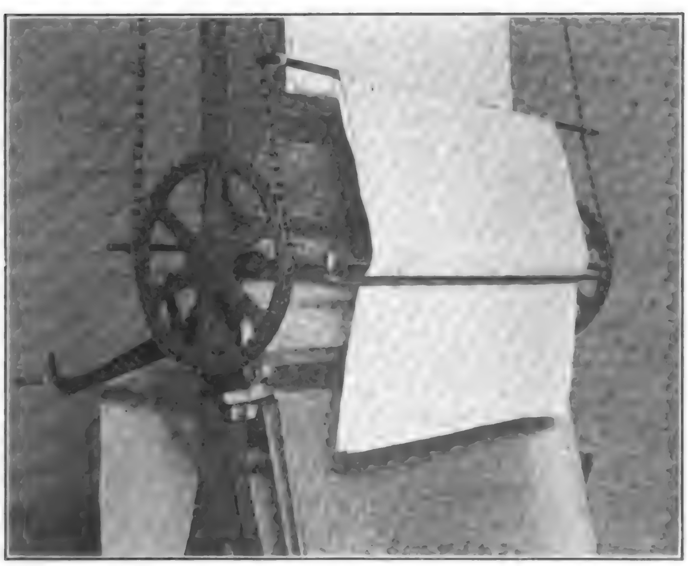


FIG. 11.—PRINT PASSING THROUGH WIPING DEVICE.

TRIAD FANS.

The Essex Electric Company, of Newark, N. J., has brought out the combination of fans shown by Fig. 13 herewith, known as the "Triad." The outfit consists of two fan motors mounted on a fixture that revolves while the fans rotate, and a governing fan above or below that is driven by the propeller action of the two fans. The power utilized in the revolution of the governing fan is transmitted through compound gearing. The fixture revolves on ball bearings, and requires no oiling or attention. The electrolier attachment is wholly independent and the fixtures and motors are dustproof. The oiling device is said to prevent the oil from spattering while the fan is revolving. At high speed the fixture revolves at 14 r.p.m., and the governing fan at a speed of 126 revolutions. The buzz fans revolve on the low speed at 1400 revolutions and on the high speed at 1800 revolutions. The revolution of the fixture may be stopped by tightening a thumb screw in the center of the fixture. The motors have a trunnion mounting, and are furnished with a two-speed switch.

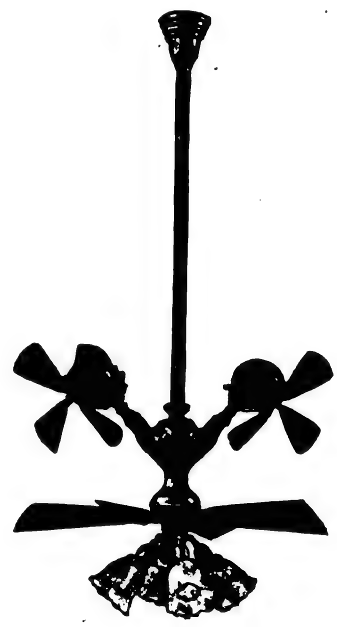


FIG. 13.—"TRIAD" FAN MOTOR.

WIRT ORGAN REGULATORS.

The Wirt Electric Company, of Philadelphia, Pa., has brought out a regulator for organ blowers where these are operated by electric motors. The regulator is connected by means of a cord to the bellows in such a manner that the upward movement of the bellows rotates the regulator switch and thereby adds resistance to the motor circuit,

reducing the speed. A counterweight acts to produce an opposite rotation, cutting resistance out of the circuit and increasing the speed of the motor. By this means an automatic regulation is secured whereby the proper amount of air in the bellows is maintained. The resistance material is a continuous ribbon wound without joint from one end of the rheostat to the other into the desired number of steps, each step making direct connection with its commutator segment. Mica is used solely for insulation purposes. The switch is a laminated brush of German silver which in

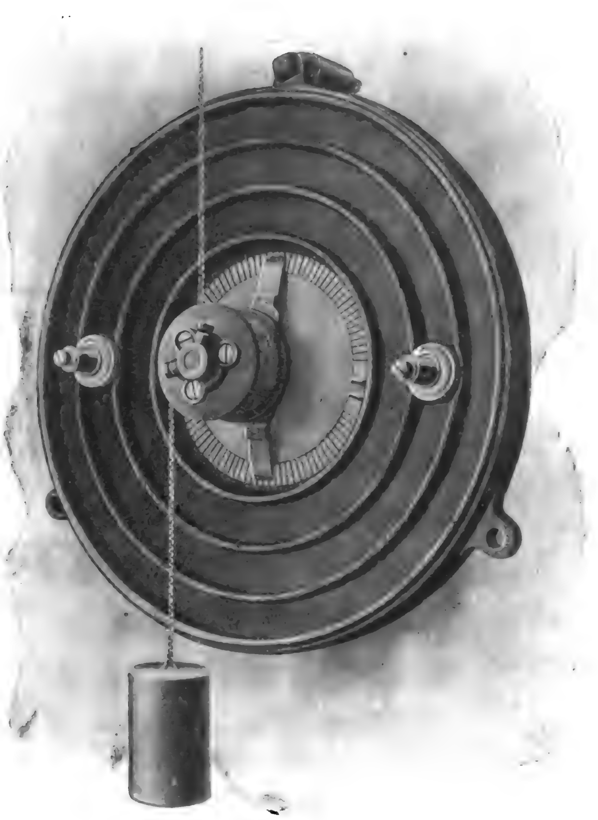


FIG. 14.—WIRT ORGAN REGULATOR.

contact with brass commutator bars gives a good running surface, fine contact and long life.

PRICE LIST WANTED.

Mr. J. S. Webster, electrical engineer for Farwell, Ozmun, Kirk & Co., St. Paul, Minn., is about to prepare specifications for the electrical equipment of a nine-story building which the firm will erect in the immediate future, and desires catalogues and prices on wiring materials, fittings, switchboard material and apparatus, panelboards, conduit fittings, electric fixtures, etc. At first current will be taken from the electric lighting company's mains, but a complete power plant will be installed later on.

TECHNICAL ADVERTISERS ORGANIZE.

The advertising representatives of a large number of concerns engaged in the manufacture of machinery and allied industries have formed an organization to be known as the Technical Publicity Association. The first annual meeting, dinner and election of officers was held in the rooms of the Hardware Club in the Postal Telegraph Building, New York, on April 27. An interesting address was delivered by Mr. E. P. Harris, well known as a broker of trade and technical journals.

OPENING OF THE MANILA STREET RAILWAY.

The first important work in the Philippine Islands to be completed since the beginning of American occupation is the Manila Street Electric Railway, which was formally opened Monday, April 10. For the past two years J. G. White & Co. have been engaged in the work of reconstructing the railways of Manila. Peculiar difficulties have been met and overcome and, where formerly there was a horse car line, with eight miles of track, built with forty-pound rail, there is now an electric system as complete as that of any city of similar size in the United States. The entire street railway system of Manila is controlled by the same syndicate, and it includes, in addition to the horse car line, a steam line running to the suburbs. Forty miles of track have been laid with 70-pound rails in the city and 94-pound rails in the suburbs. Municipal lighting privileges are also controlled by the White Company. The power will be supplied from the new power house just completed. The company operates its own printing plant, which is located in the car barn, and is used for printing time tables, circulars, tickets, etc.

THE NURNBERG VALVE-GEAR.

The Nurnberg Works in Germany desire it to be known that they use on their steam engines a trip valve gear built under their own patents (the Marx gear). On their gas engines they also use their own gear, with which the cut-off of the valve always takes place at the same time while the valve opens at different points, that is, at full load, sooner than at small loads, the time of opening being well graded. If the engine is entirely unloaded the valve opening point is so late that it coincides with the cut-off, so that the valve remains shut altogether. The opening point only is controlled by the governor, which has no effect upon the cut-off mechanism.

NOVEL INDUSTRIAL BENEFICIAL ASSOCIATION.

The shop employes of the Crocker-Wheeler Company, at Ampere, N. J., have organized a beneficial association which has a number of novel features. Every employe who pays ten cents a week to the association will be entitled to $10 a week for twenty weeks during incapacity through illness. If he dies his family will receive $100. The payment of twenty, thirty or forty cents a week entitles him to $15, $20 or $25, respectively, with death benefits of $150, $200 or $250. The plan went into effect April 3.

The company has offered to contribute an amount equal to the dues paid to the association. Thus if $6000 is paid yearly in dues, the income of the association will be $12,000. The company does not require representation in the association, which will be run entirely by the employes.

The president of the Crocker-Wheeler Beneficial Association is James Moore, who has charge of one of the big planers in the main bay of the shops. The other officers are Charles H. Brittain, vice-president; Geo. T. Owen, financial secretary; Frederick Maines, recording secretary, and William Lennox, treasurer.

FORCED DRAFT.

The argument formerly advanced against the use of forced draft instead of induced draft that it burns out the grates, seriously injures the boilers, and blows gas and smoke from the fire doors, is now seldom heard. The basis of this opinion, it is stated, originated in the experience of some engineers with plants equipped with fans operated at far above the proper speed. This was the result of installing (through ignorance) a fan too small for the work, and then forcing it above its normal speed in order to secure the desired air volume. As a consequence, instead of creating an ash-pit pressure of ¾ to 1¼ inches, which is all that is ordinarily required, the pressure was forced up to 5 or even 10 inches, with the attending objectionable results. In one instance the engineer complained of gas discharged from the fire doors, with incidental effects, and condemned forced draft out and out, although he was favorably disposed toward induced mechanical draft. Investigation showed that the fan was being operated at about 12 inches water pressure.

When forced draft is used, the air as it passes from the ash-pits to the combustion chamber is greatly reduced in pressure, owing to the resistances of the grates and the fuel. Coincidentally, the stack, even if a short one, tends to produce a partial vacuum in the furnace. As a result it is practically impossible to create under proper conditions more than a slight excess of pressure in the combustion chamber, and this should not be enough to force the gases out at the fire doors. Accurate knowledge regarding the proper application of the fan blower for this purpose will readily dissipate any false impression regarding forced draft, and should always be sought before making a decision either for or against it.—*Communicated.*

WESTINGHOUSE—GENERAL ELECTRIC.

Numerous rumors in financial and trade circles have been current during the past weeks to the effect that the Westinghouse and General Electric Companies are engaged in a trade war and that the patent agreement between the two companies has been broken. It is well known that the Westinghouse and General Electric Companies have exchanged patent licenses and under the agreement covering such exchange each company can freely use the inventions covered by patents of the other; but in other respects the two companies are active business competitors. The patent agreement was made in March, 1896, and is effective for fifteen years. In making use of the patent rights under the license each company has, however, relied upon its own experience in manufacturing and on the whole has designed and promoted its own apparatus, rather than to make a close copy of the other company's apparatus. The effect of the patent agreement has been eminently satisfactory to both the companies and their stockholders and customers. It has resulted in a total saving of about one million dollars yearly, which previously was spent in patent litigation and various other elements of time and expense. The expiration of the Tesla patents next month has stimulated competition among electrical manufacturers in the building of the induction type of motor. As a result of this the two large companies have each brought out a new type of induction motor embodying changes and improvements in the motor covered by the old Tesla patents, and which will be placed on the market at a material reduction in price. Several other electrical manufacturers are now in the market for induction motor orders and are prepared to make shipments. The expiration of the Tesla patents and the attention given this important epoch in the electrical industry by the concerns engaged in the manufacture of electrical apparatus has probably been at the bottom of the rumors to the effect that the working agreement said to exist between the two largest electrical manufacturers as to business harmony is about to be terminated.

WESTINGHOUSE CHANGES IN NEW YORK.

Westinghouse interests will occupy all but a small part of the nineteenth and twentieth floors of the new Trinity Building at 111 Broadway, New York, after May 1. The executive offices of the Westinghouse Electric & Manufacturing Company, which have for nearly twenty years been in the Equitable Life Building, at 120 Broadway, will be on the nineteenth floor of the new building, and the eastern sales offices of the Westinghouse Air Brake Company and the Westinghouse Traction Brake Company will occupy a large part of the twentieth floor. The law offices of Hunt, Hill & Betts, which have been for several years in the Equitable Life Building, will be on the twentieth floor of the new building, and the remaining part of the floor has been sublet to an engineering company.

The United States Electric Light Company, which was absorbed by the Westinghouse Electric Company shortly after the organization of the latter company, opened offices in the Equitable Life Building in 1878, and the building has been more or less a Westinghouse headquarters in New York for the past twenty-five years, and the New York office of Mr. George Westinghouse.

The New York sales offices of the Westinghouse Electric & Manufacturing Company will remain in the Hanover Bank Building at Pine and Nassau Streets, without change, and the New York office of the Westinghouse Company's publishing department, formerly at 10 Bridge Street, will be connected with them. The export offices of the electric company will continue at the same address, under the management of Mr. Maurice Coster, recently appointed to succeed Mr. F. B. H. Paine, and the office of Mr. Chas. S. Powell the new general agent of the electric company, will be connected with the sales and export offices. Messrs. Coster and Powell have arrived from Paris and from London to take up their new duties after long terms of successful service with Westinghouse interests abroad.

MACHINE TOOL MOTOR DRIVE.

At the convention of the National Machine Tool Builders' Association, held in Washington on April 11 and 12, the application of individual variable-speed motors for the driving of machine tools was discussed very fully. Mr. G. Herbert Condict, vice-president of the Electro-Dynamic Company, Bayonne, N. J., addressed the association on the subject and made the following points:

As to the advantage of the motor-driven tool over the belt-driven, it was pointed out that in the case of equiping a new shop a saving could be made in the initial cost of the power plant, owing to the fact that there will be less loss in the transmission of the power from the engine shaft to the shaft of the tool, and, therefore, a smaller power plant would be required. With the belt drive it had been practically demonstrated that the average loss in the shafting and belting amounted to at least 50 per cent. of the total power developed by the engine. This is due especially to the fact that when a belt is laced it is made as tight as possible in order to provide for stretching, and this causes undue loss of power by the excessive friction in the bearings as well as in the running of the belt itself. After the belts have run for some time they become loose, and there is a loss of power by their slipping. In the case of the line shafting itself, no matter how carefully the line may be put up in the first place, there will shortly be a certain amount of deflection, especially in a long and heavy shaft, which in time will cause a great loss in the shafting bearings, even if they are well lubricated.

In a system of electrical transmission, assuming that the shop is to be operated at say 75 per cent. of the generator capacity, so that good efficiency can be obtained from the generator itself, the loss between the engine shaft and the line will be about 6 per cent., the line loss 2 per cent. and the average loss in the motors about 17 per cent. There will also be a loss between the motor shaft and the shaft of the tool itself, where a single pair of gears or a chain drive is used of 5 per cent, or a total loss between the engine shaft and the tool shaft of about 28 per cent. Attention was called to the fact that the loss in the shafting and belting is practically a constant loss no matter whether the shop is operated at its full capacity or not, where the loss in the case of the electrical transmission varies practically with the power used. Instances were given of a plant which has been entirely equipped with individual motor drive, in which there was installed only one-half of the power capacity which had been calculated would be necessary in the case the shop had been designed for belt drive, and that this power plant had been operated on an average of only one-half of its actual capacity, thus showing that in this particular case only 25 per cent. of the power was required for running the shop with electrical transmission that had been estimated on for belt transmission.

Reference was made to a case in which a department of a machine shop was being examined, where the bulk of the tools were driven from a line of shafting, but one lathe was equipped with a variable-speed motor. A hot bearing occurred on the line shaft and shut down all tools run by the shaft and for 20 minutes 23 machines were idle, while the machinist on the motor-driven tool continued his work. As these shutdowns are liable to occur in the best regulated shop from various defects and troubles of shafting and belts, this item of saving is quite an important one.

NEW BOOKS.

SUCTION GAS. By Oswald H. Haenssgen. Cincinnati, Ohio: The Gas Engine Publishing Company. Cloth; 90 pages, 5 in. x 7 in.; several illustrations. Price, $1.00.

This little book should meet with a warm welcome from those interested in gas production and utilization for power purposes. It is a simple exposition of the methods and objects of producing suction gas and includes also data taken from tests made with this kind of gas plant in Europe.

ALTERNATING-CURRENT TESTING. By Fitzhugh Townsend. New York: D. Van Nostrand Company. Heavy paper; 32 pages, 5 in. x 8½ in.; 10 illustrations. Price, 75 cents.

The contents of this book comprise a synopsis of the course in alternating-current laboratory work which is given to the graduating classes in mechanical engineering at Columbia University. It is well prepared and covers much ground considering its mechanical size. The diction might be improved considerably in places, but the lapses are not wide enough to obscure the

author's meaning; moreover, the actual merit of the work greatly overbalances these small faults.

WEBSTER'S INTERNATIONAL DICTIONARY. (1900 revision, with additions.) Edited by W. T. Harris, Ph.D., LL.D. Springfield, Mass.: G. & C. Merriam Company. Sheep; 2350 pages, 8 in. x 11½ in. Price, $10.00.

This edition of the well-known Webster dictionary is undoubtedly the most complete work of its general kind thus far issued in a single volume. The 1890 edition was thoroughly revised in 1900, and a Supplement of 234 pages has been added to the main work. Our criterion of the character of the book naturally is the degree of correctness of its technical definitions, and all of these that we have taken the trouble to examine are astonishingly accurate and clean-cut in comparison with those usually found in general cyclopædic works of similar scope.

PERSONAL.

MR. L. E. JEANNIN has just established an electrical contract and supply business at Orlando, Fla.

MR. CHARLES DUCAS, formerly editor of the *Railroad Gazette*, has joined Mr. Ray D. Lillibridge in his business of technical publicity.

MR. A. L. ROGERS, formerly with the Stirling Company, has joined the staff of the Platt Iron Works Company's New York Office at 93 Liberty Street.

MR. RALPH D. MERSHON, the well-known consulting electrical and mechanical engineer, has removed his office to 11 Pine Street, New York. Mr. Mershon's Montreal office remains in the Street Railway Chambers.

MR. GEORGE B. DAMON, for some time manager of the New York office of the Wellman-Seaver-Morgan Company, Cleveland, Ohio, has been transferred to an important position in the engineering department at the home office.

MR. W. K. PALMER, Kansas City, Mo., recently completed plans and specifications for a hydraulic electric plant to be located on the Ninnesoah River. The plant is to be built for the Kingman (Kan.) Light & Power Company.

MR. D. B. RUSHMORE, formerly of the engineering staff of the Stanley Electric Company, Pittsfield, Mass., has been transferred to the Railway Engineering Department of the General Electric Company, Schenectady.

MR. CHARLES H. WILLIAMS, president of the Northwestern Electrical Association, has resigned the superintendency of the Madison Gas & Electric Company, Madison, Wis., to accept the general management of the Wisconsin Light & Power Company, La Crosse, Wis.

MR. GEORGE W. EDGE, eastern salesman for the Trumbull Electric Company, Plainville, Conn., has been put in charge of the company's mail order department and catalogue work, and is busily engaged in organizing a complete follow-up system.

MR. W. A. STADELMAN, who was for ten years the General Eastern Agent of the Brown Hoisting Machinery Company, has been appointed to the same position with the Wellman-Seaver-Morgan Company, Cleveland, Ohio. Mr. Stadelman's headquarters are at 42 Broadway, New York.

MR. RICHARD DEVENS, who has for several years been connected with the European office of the Brown Hoisting Machinery Company, Cleveland, Ohio, has been appointed manager of that company's New York office to succeed Mr. Stadelman, whose resignation is noted in this column.

MR. A. C. BUNKER, formerly connected with the Stanley Electric Manufacturing Company's Pacific Coast department, and more recently with the John F. Kelly Engineering Company, has joined the engineering staff of the Crocker-Wheeler Company in the alternating-current department.

MR. A. E. FLEMING, who for a number of years past has represented the Nernst Lamp Company in the capacity of District Sales Manager, with headquarters at Chicago, recently resigned his position with that company to become the Manager of the Nernst Lamp Sales Department for the Canadian Westinghouse Company, Ltd., Hamilton, Ont., and he is now actively engaged in his new duties.

MR. H. D. CRITCHFIELD, General Counsel and Sales Manager of the Automatic Electric Company, Chicago, has recovered from a long siege of serious illness and returned to his office. Mr. Critchfield was attacked by appendicitis in January and underwent an operation at the Chicago Hospital on February 1. While convalescing he was seized with pneumonia, from which he has just recovered as noted.

MR. J. H. HALLBERG, the well-known arc-lighting specialist, recently delivered an extremely interesting illustrated lecture before the Electrical Engineering Society at Columbia University on "The Application of Electricity to Heavy Freight and Trunk Line Railroads." Mr. Hallberg described in detail all of the various systems which have thus far been proposed and experimented with for trunk line service; also his own railway system for transmitting power by single-phase current and utilizing it by means of polyphase induction motors on the cars.

MR. C. E. L. BROWN, of the well-known engineering establishment of Brown, Boveri & Co., Baden, Switzerland, has been appointed consulting electrical expert for the Administrative County of London and District Electric Power Company, which is planning to construct three electric generating plants to supply the whole of London and those suburbs which are controlled by the London County Council. The generating units are to be the largest thus far constructed, consisting of turbine-generators each of 10,000 kilowatts normal output and 20,000 kilowatts maximum output ability.

TRADE PUBLICATIONS.

TELEPHONES. The Dean Electric Company, Elyria, Ohio.—Folders Nos. 1 and 2, devoted respectively to the Dean "compact type" wall telephone sets and portable desk sets.

GAS ENGINE DYNAMOS. Rochester Electric Motor Company, Rochester, N. Y.—Circular No. 52, devoted to the Rochester dynamo built for gas-engine drive in sizes ranging from 1 to 20 kilowatts.

PANELBOARD CABINETS AND COVERS. The H. O. S. Engineering Company, Newark, N. J.—An eight-page folder containing tabulated data and illustrations of H. O. S. panelboard cabinets and covers.

WATERWHEEL GOVERNORS. Lombard Governor Company, Ashland, Mass.—Bulletin No. 103, devoted to an illustrated description of the Type N Lombard governor which was recently described in this paper.

THE METAPHONE. Electric Utilities Company, New York.—A catalogue of standard size containing an illustrated description of the metaphone, which is a special type of the interior intercommunicating telephone system.

DIRECT-CURRENT MOTORS. Burke Electric Company, Erie, Pa.—This is Bulletin No. 3, devoted to the semi-enclosed "Type A M" Burke motor. The bulletin is well illustrated and the descriptive matter is very complete.

RICKARDS CORLISS ENGINES. Corliss Engine Works, Philadelphia, Pa.—A book of standard catalogue size, containing a brief illustrated description of the Rickards-Corliss steam engine and a number of testimonials from users.

NEW YANKEE DRILL GRINDER. Wilmarth & Morman Company, Grand Rapids, Mich.—Catalogue No. 90, of standard size, devoted to the well-known New Yankee drill grinder, which is now built in some twelve or fourteen styles.

MAGNETO WATCHMEN'S CLOCKS.—The Holtzer-Cabot Electric Company, Boston, Mass.—Bulletin No. 152-A, containing an illustrated description of the Holtzer magneto clock and station apparatus for recording watchmen's movements.

STEAM PUMPS. The Canton Pump Company, Canton, Ohio.—This is catalogue No. 16-B and contains brief descriptions, profusely illustrated, of the Canton simplex and duplex steam pumps for boiler feeding, condensing plants, fire service, etc.

THE HUNT NOISELESS CONVEYOR. C. W. Hunt Company, New York.—Catalogue No. 053, containing a profusely illustrated description of the Hunt noiseless conveyor in all its details and numerous illustrations of typical plants which have been installed.

SUMMER COMFORTS. The Fort Wayne Electric Works, Fort Wayne, Ind.—This is publication No. 5007 and is devoted to a detailed description of the fan motors built by this company. The pamphlet is artistically executed and of unusually attractive appearance.

CHURCH LIGHTING BY ELECTRICITY. Nernst Lamp Company, Pittsburg, Pa.—A handsomely executed brochure setting forth the merits of the Nernst lamp for lighting church interiors and containing several illustrations which go to vindicate the claims made in this direction.

SIMPLICITY THEATER DIMMERS. The Cutler-Hammer Manufacturing Company, Milwaukee, Wis.—The 1905 catalogue of Simplicity dimmers, containing a very complete illustrated description of this apparatus, with a list of users. The catalogue is well executed and attractively bound.

FAN MOTORS. Westinghouse Electric & Manfacturing Company.—Folders Nos. 4044 and 4045, the former being devoted to the Westinghouse direct-current fan motors and the latter to the alternating-current machines. Both are of vest pocket size and extremely artistic in execution.

TELEPHONE AND ANNUNCIATOR PRACTICE. Electric Gas Lighting Company, Boston, Mass.—Bulletin No. 7, containing illustrations and brief descriptions of a large number of telephone switchboards, annunciphones and intercommunicating telephone systems installed by the E. G. L. Company.

ELECTRIC LIGHTING SPECIALTIES. Faries Manufacturing Company, Decatur, Ill.—Catalogue No. 11, containing illustrations and brief descriptions of the very comprehensive Faries line of special and standard electric light fixtures, shades, reflectors, clusters, canopies, nipples, nozzles, connectors, etc.

A LITTLE MORE LIGHT. Ewing-Merkle Company, St. Louis, Mo.—This is publication No. 25, containing a great deal of valuable practical information on telephone subjects, such as line construction, estimates of installation costs, exchange operation, petitions for franchise, the organization of a company, etc.

ELECTRIC LIGHTING SPECIALTIES. The Bryant Electric Company, Bridgeport, Conn.—This is the 1905 catalogue of Bryant goods, which line comprises lamp sockets of all types, wall receptacles, rosette sockets, flush receptacles, ceiling rosettes, snap and knife-blade switches, arc lamp hanger boards and cutouts, cutout plugs for Edison plug fuses, attachment plugs, etc.

VULCAN SHAKING AND DUMPING GRATES. A. D. Granger Company, New York. Bulletin No. 4, devoted to the shaking and dumping grates built by the Granger Company. The catalogue is well executed and well illustrated. It includes also illustrations and brief descriptions of the standard forms of boiler fronts, grate bearers, etc., built by the company.

GENERAL INFORMATION BUREAUS AND TICKET OFFICES. New York Central & Hudson River Railroad.—This is No. 38 of the Four-Track Series of publications and contains in an extremely convenient form a full list of the Information Bureaus and city ticket offices of the

New York Central lines throughout the world, together with illustrations of most of the principal offices.

INDUCTION INTEGRATING WATTMETERS. Fort Wayne Electric Works, Fort Wayne, Ind.—A reprint of a very interesting paper read by Mr. A. A. Serva before the Colorado Electric Light, Power & Railway Association. The paper is liberally illustrated and contains an exposition of the principles of the induction wattmeter and a description of the type of meter built by the Fort Wayne Company.

GENERAL STATUTES RELATING TO FRANCHISES. H. M. Byllesby & Co., Chicago, Ill.—This is a compilation made by a well-known Chicago attorney for Messrs. Byllesby & Co. and published for complimentary distribution by that firm. It gives the general statutes of the various states and territories relating to the use of streets and highways by street railway, gas, water and electric light companies.

STOMBAUGH GUY ANCHOR. W. N. Matthews & Bro., St. Louis, Mo.—A very attractive illustrated catalogue entitled "Anchors That Hold," and containing a brief description of the Stombaugh guy anchors and wrenches, illustrations of the methods of installing the anchors, a report of very complete tests of the holding capacity made by Prof. Carpenter, and a number of testimonial letters from users of the anchor.

CABLE CLIPS AND HANGERS. The Chase-Shawmut Company, Newburyport, Mass.—An illustrated folder, designated Bulletin No. 30 and containing brief illustrated descriptions of the Boston cable clip, which the company has been making for several years, and the Shawmut marlin cable hanger, which is a new product designed for use in places where the Boston cable clip might be too expensive.

WATERTUBE BOILERS. E. Keeler Company, Williamsport, Pa.—This is the 1905 catalogue of this company; it is of standard size, opening at the end and finely executed. The catalogue contains illustrations and brief descriptions of the Keeler watertube boiler and settings and the Metesser superheater, together with illustrations of some notable boiler plants and practical remarks on the subjects of workmanship, supports and settings, superheated steam, circulation, lignite fuel and bagasse.

THE "STANDARD" AUTOGRAPH AND PICTURE BOOK. The Robbins & Myers Company, Springfield, Ohio.—This is an extremely ornate publication of the loose-leaf type, containing illustrations of the well-known Standard motors and fan-motors built by the Robbins & Myers Company, together with fac simile reproductions of strong testimonial letters from users of the R. & M. apparatus. The book also contains illustrations of notable installations, as well as the component parts of the latest types of Standard motors.

STIRLING. The Stirling Company, New York. —This is an elaborate publication on steam engineering topics, containing 248 pages 7½x10½ inches and profusely illustrated. The mechanical work on the book is in keeping with the highly valuable character of its contents, the latter by the way, relating only in part to the Stirling boiler, boiler setting and stoker. Impurities in boiler feed water, moisture in steam, superheated steam, fuels for boilers, the utilization of waste heat, the analysis of flue gases, and principles of steam piping are a few of the subjects treated in the book. It is an unreservedly commendable piece of work.

BUSINESS NEWS.

SHULTZ BELTING COMPANY has removed its New York office from 113 Liberty Street to 111 Chambers Street.

DIELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has established a New York office at 138 Liberty Street.

THE NEW YORK SAFETY STEAM POWER COMPANY has removed its headquarters from 115 Liberty Street to the Engineering Building, 114 Liberty Street, New York.

EWING-MERKLE ELECTRIC COMPANY, St. Louis, Mo., reports that the month of March was one of the best that it has had since its entrance into the electrical jobbing field in April, 1903.

THE COLONIAL FAN & MOTOR COMPANY has removed its executive offices from Ravenna to Warren, Ohio, where it is in much better position to handle orders and make prompt shipments.

THE TROY ELECTRICAL COMPANY, Troy, N. Y., has improved the appearance of its line of voltmeters and ammeters (described in this paper last February) by substituting a faceplate of much handsomer design; the movement remains unchanged.

THE GEORGE W. LORD COMPANY, Philadelphia, manufacturer of boiler feed-water compounds, has shipped abroad since the first of this year 50,000 pounds of compound to India, 30,000 pounds to Liverpool, Eng., and 30,000 pounds to London.

GENERAL INCANDESCENT ARC LIGHT COMPANY, New York, calls attention to the fact that the order for the 4000 or more Wright demand meters which the Boston Edison Company is to install, as noted in our last issue, was placed with it.

THE PITTSBURG GAGE & SUPPLY COMPANY, Pittsburg, Pa., has been awarded the contract for a large oiling system to be installed in the new plant of the National Tube Company, Lorain, Ohio. The White Star oiling system will be installed of course.

THE BLISS ELECTRICAL SCHOOL, Washington, D. C., reports that at present there are on its rolls students from more than thirty states and that electrical positions are filled by its graduates in nearly every state of the Union and in many foreign countries.

THE STIRLING COMPANY, builder of the well-known Stirling boiler, has removed its executive offices from the Pullman Building, Chicago, to the Trinity Building, New York. The offices in the Pullman Building will, however, be continued as Western sales offices.

JOHN L. GLEASON, Jamaica Plain, Mass., has arranged with the Central Electric Company, Chicago, and the Commercial Electric Supply Company, St. Louis, to carry in stock a supply of his molding boxes and to act as his exclusive representatives in their respective territories.

NORTHWESTERN ELECTRIC EQUIPMENT COMPANY, St. Paul, Minn., reports that it has been admitted to membership in the National Jobbers' Association and has gone into the electrical supply business on a large scale. The company's stock of supplies is said to be one of the most complete in the Northwest.

THE ELECTRIC GAS LIGHTING COMPANY, Boston, Mass., has recently supplied "Rotokoll" telephone switchboard outfits for the State Normal School, Chicago, the Naugatuck (Conn.) High School and is building a similar switchboard for the Brockton (Mass.) High School. They have also recently equipped a number of factories with similar outfits.

AMERICAN CIRCULAR LOOM COMPANY, Chelsea, Mass., states that the National Board of Fire Underwriters has cancelled the specifications of Rule 50-C of the National Code, referring to the construction of flexible tubing, and has restored to the list of approved fittings "Circular Loom" of the type manufactured by the American Company during the past twelve years.

THE ARNOLD COMPANY is the new name of the progressive concern heretofore known as the Arnold Electric Power Station Company, the headquarters of which are in the Marquette Building, Chicago. The change in name is the only one which the company has undergone; it will continue along the lines heretofore followed, under the direction of its energetic president, Mr. Bion J. Arnold.

C & C ELECTRIC COMPANY has removed its general offices from 143 Liberty Street, New York, to the works at Garwood, N. J., this step having been found expedient on account of the necessity for close touch between the general offices and the factory and the difficulty of maintaining this under the great increase in business. A branch office will be maintained, however, at 149 Broadway, New York.

ALLIS-CHALMERS COMPANY, Milwaukee, has removed its general offices from Chicago to Milwaukee in order to be in closer touch with the works. The company has decided to begin immediately an extension to the Milwaukee works for the manufacture of electrical machinery of all kinds, and the construction of steam turbines, hydraulic turbines and gas engines. This extension, it is estimated, will cost about $3,000,000.

THE AMERICAN DIESEL ENGINE COMPANY, New York, announces the closing of contracts recently for Diesel engine installations as follows: Baldwin Locomotive Works, 450 horse-power; Gorham Manufacturing Company, 450 horse-power; Citizens' Electric Light & Ice Company, Lebanon, Ind., 345 horse-power; Baxter Springs (Kan.) Electric Company, 75 horse-power;; the Effingham (Ill.) Light & Power Company, 240 horse-power.

THE DODGE COAL STORAGE COMPANY, New York, has acquired from the United Telpherage Company the exclusive right to manufacture and sell the telpherage systems hitherto manufactured and marketed by the latter company in the United States. All current correspondence, plans, drawings, etc., have been transferred to the Dodge Coal Storage Company, New York, and future communications concerning telpherage outfits should be addressed to that company.

THE NATIONAL ELEVATOR COMPANY, Honesdale, Pa., and New York City, under the new management has closed a number of important contracts recently for elevators in large apartment houses in New York, as well as installations in buildings of other classes. Mr. H. F. Guerney is president of the reorganized company, and Mr. R. E. Carichoff, the well-known elevator specialist, is consulting engineer. The company recently established new offices at 400 West 23d Street, New York.

FREDERICK PEARCE COMPANY is the style of a new corporation, chartered under the laws of the State of New York, which has succeeded to the business of Frederick Pearce. Mr. Pearce is president of the new company; his son, Charles F. Pearce, vice-president; and Mr. George H. Tamlyn, secretary and treasurer. The company will continue the well-known lines of telephone, telegraph and electric light apparatus previously built by Mr. Pearce, and will considerably enlarge the scope of the business.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., reports a flourishing business in its line of work, having closed contracts recently for a large number of switchboards. Among these is a contract with the United States Telephone Company, of Columbus, Ohio, for a tollboard which is said to be the largest one ever built for an independent telephone company. The contract includes all of the equipment necessary for the board, together with a test board, a chief operator's desk, a switching section and a messenger call box.

BROWN-CORLISS ENGINE COMPANY, Corliss, Wis., recently received an order from the National Tube Company for two 38-in. and 70-in. x 60-in. tandem compound rolling mill engines for especially heavy work at the McKeesport plant. This important contract was secured by reason of the satisfactory performance of a 19-in. mill engine formerly built by the Brown Company. The company now has twenty-six engines going through its shops, including the 20,000,000-gal. pumping engine for the city of Milwaukee, which was mentioned in this column a few months ago.

THE MURRAY IRON WORKS COMPANY, Burlington, Ia., is constantly receiving strong testimonials to the merits of its well-known Corliss engines. The company has bound in convenient form fac simile reproductions of a large number of these letters and classified them according to the character of work done by the engines. Book No. 1, for example, contains the letters relating to engines used in electrical work; book No. 2, those relating to engines used by railroads, mines, cotton mills, lumber mills, and similar establishments; No. 3, flour mills and elevators, and No. 4, oil mills. All of the testimonials are unqualifiedly favorable.

CLEVELAND ARMATURE WORKS, Cleveland, Ohio, has established an engineering department based on its extensive experience in the repairing of electrical machinery during the past ten years and a careful analysis of the design and construction of the various lines of machines built in this country. The new department, by reason of the company's unique experience, is well qualified for getting up special designs for dynamos, motors, lifting magnets and other electrical apparatus, revising existing lines, and supplying all of the preliminary calculations and data for any concern proposing to establish an electrical manufacturing business.

MARINE ENGINE & MACHINE COMPANY, Newark, N. J., announces that the Armington & Sims engines, which it recently made arrangements to manufacture, will be built in sizes ranging from 10 to 3000 horse-power, in both horizontal and vertical types, in side-crank and center-crank forms, simple and non-condensing, in high, medium and slow speeds, with single valve and with Corliss valves, and adapted to direct-connection or other modern requirements. Mr. Gardner C. Sims has acquired an interest in the company's business and becomes its general manager. As noted in last month's issue, the engines will be built under Mr. Sims' personal direction.

THE NILES-BEMENT-POND COMPANY has announced the purchase of a large factory property at Nicetown, Philadelphia, formerly occupied by the Cresswell & Waters Company, for an addition to its Philadelphia plants. This property will be greatly improved and equipped with modern facilities for use as a foundry for the Bement-Niles Works branch of the company at 21st and Callowhill Streets, and also the Niles Crane Works branch at Meadow and Mifflin Streets. This increase of facilities is one of the many important developments that have been made by the Niles-Bement-Pond Company recently, owing to the recent large increase of business and many large contracts which have been taken. The combined plants in Philadelphia, regardless of the three other large plants operated by the company at Hamilton, Ohio; Plainfield, N. J., and Hartford, Conn., will now employ about 2,000 men.

NATIONAL ELECTRIC COMPANY.—The First National Bank, Milwaukee, having had assigned to it about two-thirds of the capital stock of the National Electric Company to secure loans, has taken over the control of the latter company. John I. Beggs, Charles F. Pfister, Frederick Vogel, Jr., J. H. Van Dyke, Jr., all First National Bank directors, have been elected directors of the National Electric Company, replacing S. W. Watkins, president, F. H. Bigelow, chairman of the board, F. C. Randall, director, vice-president and general manager, and Gordon Bigelow. Former directors, A. N. McGeoch and B. T. Becker, remain on the board. John I. Beggs has been elected to and accepted the presidency of the company and will direct its affairs. The business of the company will be actively continued and all contracts will be promptly completed. The indebtedness of the company is now being ascertained and, when known, a meeting of the creditors will be called to consider the best plan to protect all creditors and promote the future welfare and progress of the company.

GENERAL ELECTRIC COMPANY has just brought out two new lines of motors, one a direct-current and the other an induction motor. The new direct-current line ranges from 20 to 185 horse-power, and the machines are all six-pole, with laminated magnet poles bolted to a steel yoke ring and journal brackets of the ring and spider type; these motors are provided with sliding bases and may be mounted on the floor, wall or ceiling. The alternating-current line ranges from 1 to 35 horse-power, and differs from the well-known line hitherto built chiefly in the form of frame employed. Instead of the usual circular housing with slots for ventilation, the containing frame consists of two rings united by horizontal struts at sufficiently close intervals for mechanical strength, the whole being cast in one piece; the stator is mounted in this skeleton frame and the journals are in ring-and-spider brackets very similar to those used on direct-current machines. The new frame gives vastly more effective radiating surface, better ventilation and less weight, without sacrificing any protective features.

C. H. WHEELER CONDENSER & PUMP COMPANY.—The announcement is made that the Barr Pump Company, of Philadelphia, has been taken over by a new company to be known as the C. H. Wheeler Condenser & Pump Company. Mr. C. H. Wheeler, formerly president and manager of the Wheeler Condenser & Engineering Company, is now identified solely with the new company. The personal services of Mr. Wheeler, ample capital, modernly equipped works and an up-to-date engineering staff, place the company in a position of unusual strength on condensing apparatus and pumps of any size and description for all purposes where such machinery is required. The company's principal office is in Philadelphia at Lehigh Avenue and 18th Street, and the New York branch is at 26 Cortlandt Street. Additional branches in Chicago and other large cities will soon be established. The officers of the company are John Pitcairn, president; George Burnham, Jr., who is connected with the Baldwin Locomotive Works of Philadelphia, vice-president; C. H. Wheeler, secretary and general manager; Otto W. Schaum, works manager; W. H. Rometsch, of the Fletcher Works, Philadelphia, treasurer.

CENTRAL STATION NEWS

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

ALABAMA.

TUSKEGEE.—The Council is reported to have decided to construct an electric light plant.

LUVERNE.—The Luverne Electric Light & Water Company has been incorporated with a capital of $10,000, by J. R. Horn, J. M. Cody, R. G. Reddach and others.

LINEVILLE.—The Council has granted to John S. Jamison and associates a franchise for water works and an electric light plant, also telegraph and telephone systems.

ARKANSAS.

EL DORADO.—The new electric light plant, which has been in course of construction for some time, is nearing completion, and it is expected that the town will soon be lighted from that source.

FORREST CITY.—W. M. Partridge is said to have recently acquired a half interest in the plant of the Forrest City Light & Power Company, but none of the details of the transaction have been made public.

CALIFORNIA.

SEBASTOPOL.—The Sebastopol Light, Power & Water Company was recently incorporated with a capital of $25,000, by W. P. English, G. W. Kingsbury and A. B. Swain, of this city.

SAN FRANCISCO.—The new power station of the Mutual Electric Light Company, at the corner of Spear and Folsom Streets, has been running for about six weeks and is giving entire satisfaction.

MODESTO.—It is stated that the Tuolumne Electric Company recently applied for a franchise to erect poles and string wires along the county roads for the transmission of electric current, and bids for said franchise will be received until May 2.

SAN LUIS OBISPO.—The San Luis Obispo Gas & Electric Company is contemplating the construction of an electric light plant, the cost of which is estimated at $30,000. It will be situated near the gas works in this city. Mr. B. F. Thomas is manager of the company.

COLORADO.

GUNNISON.—The citizens voted recently for an issue of bonds to the amount of $100,000, the proceeds to be used in constructing water works and an electric light plant.

STERLING.—The Sterling Public Service Company's plant was burned to the ground on the 20th of April. The building was a total loss. The boilers and engines can be repaired. Generators, switchboard and all supplies are already on hand. The loss is estimated at $8000.

CONNECTICUT.

CHESHIRE.—The Town Council is considering the advisability of establishing a municipal electric light plant.

FLORIDA.

JACKSONVILLE.—The Aultman & Taylor Machinery Company was awarded the contract for supplying a new boiler to the electric light plant here at a cost of $4300.

GEORGIA.

MONROE.—J. B. McCrary, of Senoia, has been selected to prepare plans for an electric light plant. Bonds for the purpose will be issued to the amount of $15,000.

GAINESVILLE.—The North Georgia Electric Company is about to commence the erection of a large dam at Wilson's Shoals, on the Chattahoochee River It will cost approximately $150,000 and 100 men will be employed on the work, which is expected to require a year to complete. About 2500 horse-power will be generated and transmitted to the city for distribution to the various enterprises requiring it. This will be the fifth dam erected by this company. Three have been built on the Chestatee River and one has already been erected on the Chattahoochee River at the Dunlap Shoals. The lower dam on the Chestatee River supplies power to the city, while the two higher up on the river furnish power to Dahlonega plants. The Chattahoochee dam gives current to the street railway system now in operation here. Wilson's Shoals are five miles west of Gainesville and the dam there will be seven miles below the one at Chattahoochee Park. It will be 35 feet high and 600 feet long.

IDAHO.

LEWISTON.—Francis Jenkins, of Moscow, is said to be interested in the construction of a power plant at Elk Creek Falls, near here.

WEISER.—John R. Pierce, Pitts Ellis, W. H. Adams, T. C. Galloway and J. H. Morrison have incorporated the Weiser Electric Light & Power Company, having a capital stock of $50,000. A power plant, estimated to cost $32,000, will be constructed on the Weiser River and pushed to completion as rapidly as possible.

ILLINOIS.

CHICAGO.—A new engine and generator are to be installed in the Chicago Avenue pumping station.

MACKINAW.—The new electric light system is now in operation here and proving very satisfactory.

CHICAGO.—The Western Water, Light & Traction Company has been incorporated with a capital of $10,000.

HENRY.—The plant of the Henry Electric Company, formerly owned by the Messrs. Sterrett, has been sold to J. J. Crickenberger.

WOODHULL.—The plant of the Woodhull Electric Light Company is said to have been destroyed by fire recently, but the extent of the loss is not known.

PARIS.—The electric light and gas plants have been sold to J. N. C. Shumway, of Taylorville, who is said to be the Western agent of a syndicate of Eastern capitalists.

MIDDLETOWN.—Mr. Sturgis, former proprietor of the electric light plant here, recently traded his interest in the same to W. A. Crawford for residential property owned by the latter in Delavan.

CHICAGO.—It is stated that the Chicago Edison Company is about to erect a sub-station at 8284 Market Street. The plans are being prepared by Shepley, Rutan & Coolidge. It will be a two-story building, 40 x 100 feet, built of brick and stone, and will cost $75,000.

MARSEILLES.—The water works and electric light plant, heretofore operated by the Marseilles Land & Water Power Company, are said to have passed under the control of a new corporation, known as the Consolidated Water & Light Company, and having a capital of $100,000. It is proposed to erect a new power house, the old water works station is to be torn down and the flume enlarged. It is also proposed to install an auxiliary steam plant. John M. Nicholson is president of the new concern, and A. E. Cooper, secretary.

INDIANA.

LA PORTE.—Frank R. Northam has been appointed receiver for the Edwards Railway & Electric Light Company.

HOPE.—The contract for the new electric light plant to be erected in this city has been awarded to the Ryan Construction Company, of Indianapolis.

LEBANON.—It is reported that Cropsey & Lamm, of Cincinnati, are preparing plans for an electric and cold-storage plant to be constructed here.

CONNERSVILLE.—The Connersville Gas, Electric & Power Company's plant has been sold to George B. Markle, of Hazleton, Pa., who will expend a considerable sum in improvements.

LIGONIER.—Bids are being considered for lighting the city by electricity for a term of ten years from November, 1905, with forty or more 2000-c.p. enclosed-arc lamps; also for furnishing an incandescent sysem of electric lighting, and a system of commercial arc lights for business houses and residences for the same term of years.

MISHAWAKA.—The plans for the organization of the Indiana & Michigan Electric Company have been consummated and the company has filed articles of incorporation. A plant will be erected on the St. Joseph River, whence power will be distributed throughout Indiana and Michigan for lighting and operating trolley lines and manufacturing plants.

MUNCIE.—The Citizens' Electric Light Company, capitalized at $200,000, and composed largely of Muncie business men, has been organized for the purpose of supplying electric light to Muncie people at a cost of 5 cents a thousand watts instead of 12 cents, which is the charge now made for supplying lights for commercial purposes. William F. Warner is president and C. R. Hathaway, secretary.

INDIAN TERRITORY.

COWETA.—The Coweta Electric Light Company has completed its plant and is wiring the town. Orders have been received for over 200 lights, besides those furnished the municipality.

MUSKOGEE.—The Grand River Power Company has been organized and incorporated, with a capital of $10,000. A 40,000-h.p. plant will be constructed on the Grand River, about eleven miles below here. Current for lighting and power purposes will be furnished to this city, and Wagoner and Fort Gibson are also interested in the project. C. N. Haskell is president and Carl Pursell, secretary, both of this city.

IOWA.

LETTS.—An electric light plant is to be installed in this city by the Reinz Company.

CONRAD.—W. J. Stanton is interested in the construction of an electric light plant here.

SIOUX CITY.—Samuel McRoberts and Edward Tilden have been granted a franchise to establish an electric light plant in this city.

MISSOURI VALLEY.—L. A. Little is said to have succeeded to the entire business of the Missouri Valley Electric Light Company.

WINTERSET.—The Des Moines Heat, Light & Water Company, of Des Moines, is reported to be considering the advisability of putting in a central heating plant and water works at this place, at a cost of $60,000.

KANSAS.

LINDSBORG.—Bids are being considered for the construction of a municipal lighting plant to cost $29,000. George C. Morgan, of Chicago, is the engineer in charge of the work.

ELLSWORTH.—Paul Reaume is said to have purchased a portion of the lot on which is located the Ellsworth Electric Light Company's plant. Reports state that Mr. Reaume will be interested in the construction of a new power house in the near future.

LYONS.—The Lyons Electric & Manufacturing Company will receive bids about May 10 for machinery for an electric light plant, which will cost from $8000 to $10,000. The company has engaged a superintendent and will construct the plant by its own labor. The new concern has been granted a twenty-year franchise.

KINGMAN.—The plans and specifications have been completed for the hydro-electric power station of the Kingman Light & Power Company, a concern recently incorporated with a capital of $25,000. The plant will be operated by means of water power derived from the Minnescah River, and an auxiliary plant will be installed equipped with a gas engine and suction gas producer.

WAVERLY.—The contracts for constructing an electric light plant have been awarded as follows: For engine, boiler, pipe and fittings, English Iron Works, Kansas City, Mo.; generator exciter and switchboard, Hodge-Walsh Electrical Company, Kansas City; heater, trap separators, feed pump, etc., Kansas City Engineering Company, and lamp and pole line equipment, to the B-R Electric Company, of Kansas City.

KENTUCKY.

LAWRENCEBURG.—Bids will probably be received shortly for the proposed electric light plant to cost $12,000. Address W. E. Dowling, of the Commercial Club.

CARLISLE.—A company has been organized here, with C. C. Cole as president; M. V. Bostain, vice-president; George A. Straus, secretary, and John N. Riss, treasurer. Active construction work has been begun on a $15,000 electric light plant, and it is hoped to have it in operation about the first of June.

DANVILLE.—The Danville Light, Power & Traction Company has filed articles of incorporation. The following are the officers: President, Charles C. Fox; vice-president, Walter T. Scott; secretary, treasurer and general manager, Arnold Honegger. Work will begin at once on an up-to-date electric light plant.

LOUISIANA.

HOMER.—Charles H. Levy, consulting engineer, of Shreveport, writes that it is proposed to construct water works and an electric light plant here at a cost of $20,000.

LAKE CHARLES.—Bids are being considered by the Council for furnishing the city with electric lights; also for the sale of the franchise for the use of the streets for electric lighting.

AMITE CITY.—H. C. Hull, of this city, and Hyman C. Reed, of New Orleans, are erecting an electric light and power plant here. The plant will also furnish lights to Roseland and Independence.

MAINE.

BRADLEY.—Local press reports state that Fred W. Ayer, of Bangor, and associates, will construct an electric plant for the generation and distribution of electricity for power purposes in Bradley.

PORTLAND.—The Cascade Light & Power Company has been incorporated with a capital of $100,000 to manufacture and distribute gas and electricity. C. C. Hight, of Boston, is president, and L. L. Hight, of this city, is secretary.

BANGOR.—Report is received of the consolidation of the Oldtown Electric Light Company, the Bangor, Orono & Oldtown Railway Company, the Public Works Company, and the Bangor, Hampden & Winterport Railway Company, under the name of the Bangor Railway & Electric Company. The company is capitalized at $1,000,000.

BANGOR.—Maine people and especially those on the northeastern border will be interested to learn that the Grand Falls Power Company has been incorporated at Ottawa, Ont., with a capital stock of $200,000. The incorporators are: Sir William C. Van Horne, of Montreal; U. S. Senator Redfield Proctor, of Proctor, Vt.; Richard B. Angus, of Montreal; Hugh Havlock McLean, of St. John, N. B.; Frank C. Partridge, of Proctor, Vt.; Frank Ray Kimbley, of New York, and Ernest Alexander of Montreal. The company's plans include the construction of a canal and hydraulic raceway, dams, conduits, buildings, wharves, reservoirs, flumes, railways and all other improvements necessary for the successful development of power at Grand Falls, N. B.

MARYLAND.

MARYLAND.—Plans have been completed by the Baltimore County Water & Electric Company for a power house to be erected at Herring Run. S. W. Cooper, Highlandtown, is chief engineer and superintendent.

MASSACHUSETTS.

MANSFIELD.—At a town meeting held recently it was voted to extend the electric lighting system to West Mansfield station.

HOLYOKE.—The Holyoke Water Power Company is completing plans for utilizing the surplus water of Connecticut River; it is proposed to expend about $60,000.

MICHIGAN.

L'ANSE.—It is stated that $10,000 bonds will be issued for the construction of an electric light plant.

JACKSON.—The Commonwealth Power Company has let the contract for a $100,000 steam power plant to be constructed by them here.

DETROIT.—The House is reported to have passed a bill granting permission to the city to issue $150,000 bonds for lighting improvements.

BARAGA.—The Legislature has passed a bill allowing this village to issue $40,000 bonds for the construction of an electric light plant and water works.

MENDON.—The citizens have voted to issue bonds to the amount of $15,000, the proceeds of which will be used to establish water works and an electric light plant.

MUSKEGON.—The ordinance granting to the Morton B. Wheeler Company a franchise to furnish electric light and power within the limits of Muskegon has been passed by the Council.

MENOMINEE.—Reports state that Holmes & Son, of this city, are perfecting plans for the construction of a dam and canal at Grand Rapids on the Menominee River, which will furnish electric power to the amount of from 4000 to 10,000 horsepower. The company owns the land on both sides of the river at Grand Rapids and has recently secured a charter for the establishment of a power plant at that point.

PENTWATER.—The Oceana Electric Company has been succeeded by the Oceana Electric Light & Power Company, Inc., with B. C. Lindley, who was manager of the former company, as president. The company is now in the market for bids for the construction of a hydro-electric plant in this vicinity, the equipment to include two direct-connected units of 400 and 300 horse-power capacity and about 38 miles of 25,000-volt lines. It is desired that the work proceed as far as possible before winter.

MINNESOTA.

DULUTH.—Bonds are being sold to the amount of $140,000 for water works and a lighting plant.

TORAH.—The Torah Telephone & Improvement Company has been incorporated to construct water works, an electric light or gas plant and a telephone exchange.

MINNEAPOLIS.—Notice is received of the incorporation of the International Lighting Company, with a capital of $2000, by C. W. Jenne, J. W. Furber and others.

WINONA.—An ordinance authorizing the Minnesota Light & Power Company to erect and maintain poles and string wires in the streets of the village has been passed.

WALKER.—Bids are being considered by the Village Council for the removal and extension of the electric light and water plant, for which $4000 bonds were recently issued.

FAIRMONT.—The citizens voted April 4 to issue $18,000 bonds for improving the electric light plant and installing water works, and $10,000 for establishing a sewerage system.

SANBORN.—It was voted at a recent election, held for the purpose of deciding the matter, to issue bonds to the amount of $6000 for the installation of a village lighting plant.

MINNEAPOLIS.—Reports state that the Minneapolis General Electric Company is about to let contracts for work in connection with utilizing the water power of St. Croix River, at St. Croix Falls, between the villages of St. Croix Falls and Taylor's Falls, this State.

FERGUS FALLS.—The City Council and Electric Light Commission have decided to rebuild the dam which supplies the city's electric light plant with power. It is proposed to build a cement dam if the bottom of the river is found to be suitable, and the new structure will be several feet higher than the old one as more power is needed. Its cost will be over $40,000.

MINNEAPOLIS.—Joseph L. Kuchle is reported to have filed with the city a bond and acceptance by the Minnesota Power & Trolley Company, of the ordinance granting the right to use the city streets for conduits and poles, to convey electric energy to the city, and to supply electric light and power to consumers. The company agrees to begin actual work on construction and expend at least $200,000 within one year.

MISSISSIPPI.

LIBERTY.—The Board of Aldermen has granted W. M. White a franchise for water works and an electric light plant.

ROSEDALE.—A committee has been appointed to procure estimates on the cost of an electric light plant to be operated in connection with the municipal water works.

GULFPORT.—The City Council has passed an ordinance granting Capt. J. T. Jones and associates a fifty-year franchise for an electric railway, light and power plant.

MERIDIAN.—Mayor J. H. Rives will receive bids May 1 for furnishing 200 1200-c.p. arc lights for a period of five years from May 1, 1906; 200 or more alternating-current enclosed-arc lamps, 66 amperes each, potential of not less than 72 volts between the terminals of each arc lamp and an apparent wattage of 475 watts for each lamp; lamps in the business section to burn all night, others to run on moonlight schedule. A franchise will be granted to the successful bidder.

MISSOURI.

TROY.—The City Council has purchased a site for the municipal electric light plant.

MADISON.—The citizens voted April 4 to issue $5000 bonds for an electric light plant.

LAWSON.—Michael Maloney, of Chillicothe, is said to be negotiating for the purchase of the electric light plant of this place.

MARSHALL.—A. H. Bickmore & Co., of New York City, have purchased the gas and electric light plants of this place. The two plants will be consolidated and extensively improved.

NEBRASKA.

LINCOLN.—The poles have arrived for the municipal lighting plant and construction work will be pushed rapidly.

ARLINGTON.—The Arlington Electric Light Company has been incorporated by G. F. Upland and others. The company's capital is placed at $10,000.

DODGE.—It is proposed to construct water works and an electric light plant here at a cost of $10,000. Bonds for the purpose will be issued shortly. No engineer for the work has been selected as yet.

NEW HAMPSHIRE.

LACONIA.—Reports are to the effect that Massachusetts and Rhode Island capitalists have purchased the plant of the Laconia Electric Light Company and will enlarge it. The latter company was recently awarded the contract for lighting the city for a period of ten years for about $7000.

NEW JERSEY.

DUNELLEN.—Edwin W. Hine, representing the Public Service Corporation, has petitioned the Borough Council for a franchise to lay pipe through the town.

LAMBERTVILLE.—The Lambertville Heat, Light & Power Company has been awarded the contract to wire the Centenary M. E. Church for electric lighting.

WOODBURY.—Articles of incorporation for the Gloucester County Electric Company have been filed by Enos R. Artman and Daniel Eady. The company is capitalized at $50,000 and will generate and distribute electricity.

ATLANTIC CITY.—The Atlantic City Suburban Electric Company is reported incorporated with a capital of $100,000 to furnish heat, light and power. It will petition for a franchise in Pleasantville. Among the incorporators are Louis E. Kuehale, Harry E. Woodman and John C. Reed.

NEW MEXICO.

ROSWELL.—The Citizens' Light, Heat & Power Company has been incorporated with a capital of $100,000. J. A. Buckley, of Kingfisher, Okla. Ter., is one of the incorporators.

NEW YORK.

SPRINGVILLE.—Bonds are to be sold to the amount of $12,000 for the erection of an electric lighting plant.

TONAWANDA.—The Niagara, Lockport & Ontario Power Company has petitioned the Council for a franchise.

POTSDAM.—The citizens have voted to issue $40,000 bonds for the installation of a municipal electric light plant.

CLINTON.—The Governor has signed the bill authorizing the city to issue $7000 bonds for an electric light plant.

WHEATFIELD.—The Niagara, Lockport & Ontario Power Company has petitioned for a franchise in Wheatfield.

SALAMANCA.—C. F. Buckmaster, City Clerk, writes that the citizens have voted to purchase the electric light plant and water works.

NEW YORK CITY.—The Williamsburg Power Company, with a capital of $150,000, has been incorporated by E. P. Foster, James Foster and W. H. Robinson.

LIVONIA.—Articles of incorporation have been filed for the Livonia Light & Heat Company by E. C. Blake and F. A. Wicker. The company is capitalized at $12,000.

PENDLETON.—The Town Council has granted the Niagara, Lockport & Ontario Power Company a franchise to construct a power canal and transmission line through the town.

ROCHESTER.—Contracts have been made by the Rochester Railway & Light Company for new buildings, improvements and additions, involving an outlay of more than a million dollars this year.

NEW YORK CITY.—The incorporation is reported of the Morgan & Wyman Electric Light & Power Company with a capital stock of $6000. C. B. and Cora Morgan, of Armenia, N. Y., and C. S. Wyman, of Dover Plain, are the incorporators.

NEW YORK CITY.—The Manticaw Light, Heat & Power Company has filed articles of incorporation, stating its capital stock to be $50,000. Among those interested in the project are Michael F. Burns, of Brooklyn, and Solomon M. Shatzkin, of Passaic.

MONROE.—Z. Paddleford and Luther Terwilliger are said to be among the incorporators of a company organized under the title of the Orange & Rockland Electric Company. The company is capitalized at $50,000, and the directors hope to have the plant in operation early in July. It will be located in Monroe and current will be furnished for lighting this city, Chester and other surrounding villages.

GLENS FALLS.—Eugene L. Ashley, president of the Hudson River Water Power Company, has announced that he has contracted to furnish the New York Central 25,000 electrical horse-power yearly for twenty-five years. The minimum charge will be $125,000 per year, and the contract may cost the Central as high as a half million a year. Power will be delivered in July from Spier Falls and Schoharie Falls, together with a current from a temporary steam plant to be erected at Utica. The energy will be used in the development of the various trolley interests which the Central railroad is fast taking up. The Power Company will now hasten its plants for utilizing the waters of the Schoharie River. One power plant has already been built and four more will follow. This work will be completed in about two years and until that time the Utica steam plant will be utilized to fulfill the Central contra

NORTH CAROLINA.

SPENCER.—The Board of Aldermen has awarded to the Salisbury & Spencer Street Railway Company the contract to install a system of electric lights in Spencer, the system to be in operation by May 15.

NORTH DAKOTA.

JAMESTOWN.—The Jamestown electric light plant is to be enlarged and improved, reports state.

GRAND FORKS.—The citizens voted April 3 to issue $30,000 bonds for the construction of a municipal electric light plant.

OHIO.

ARCANUM.—It has been voted by the citizens to issue $38,000 electric light and water bonds.

MADISON.—The question of establishing an electric light plant is said to be under consideration here.

LOCKLAND.—The citizens have voted to issue $27,000 bonds for extending the water mains and enlarging the electric light plant.

URBANA.—J. C. Powers, Paul C. Martin, and others, have filed articles of incorporation for the Urbana Light Company, with a capital of $100,000.

BELPRE.—There is reported to be a movement on foot here looking to the construction of a water works system and an electric light plant.

CLEVELAND.—The Cleveland Electric Illuminating Company has been granted a permit for the erection of a lighting station at 1845 Doan Street, to cost $12,000.

LINTON.—The Linton Light, Power & Fuel Company was recently incorporated by F. C. Roundy, J. W. Swatek and John McMadden, the company being capitalized at $125,000.

SPRINGFIELD.—Local reports state that if the E. S. Kelly Home Heating, Light & Power Company secures a blanket franchise, it will expend $50,000 this year in improvements.

GALION.—The Crawford Gas & Electric Company has filed articles of incorporation, stating its capital stock to be $150,000. Among these interested in the project are S. N. Blake and P. P. Jenks.

CLEVELAND.—The People's Electric Lighting & Power Company, having a capital of $10,000, has filed articles of incorporation, naming among others H. T. Emerson and William Brodie as incorporators.

MAUMEE.—The Public Service Company has been incorporated for the purpose of conducting electric lighting and heating plants. The company has a capital of $50,000, and among the incorporators are George McGovern, James H. Ragan and Thomas H. Harper.

DAYTON.—The Montgomery County Electric Company, which was recently incorporated with a capital of $100,000, is said to have been consolidated with the Dayton Electric Light Company. The new concern will be known as the Dayton

Lighting Company and is capitalized at $2,500,000. About $1,000,000 will be spent in new equipment, it is said, $600,000 worth of new machinery having already been ordered. The officers of the combined company are reported as follows: President, J. E. Lowes; vice-president, H. E. Runkle; secretary and assistant treasurer, R. E. DeWeese.

OREGON.

SALEM.—H. D. Wagnon, an attorney of Portland, is said to be interested in the construction of an electric light and power plant at this place.

OREGON CITY.—The Portland General Electric Company has petitioned the County Commissioners for a franchise over the county roads between Oregon City and Aurora. It will also petition for a franchise in Marion County for a transmission line between Aurora and Salem.

PENNSYLVANIA.

ALLENTOWN.—A well-organized movement is on foot here looking to the establishment of a new electric light company.

WELLSBORO.—It is stated that the Wellsboro Electric Light Company will erect a power plant here this summer. W. S. Culver is superintendent.

ALTOONA.—The Citizens' Electric Light, Heat & Power Company, it is said, will build a number of extensions to its lines during the coming summer.

DEBRING.—P. J. Edwards, proprietor of the electric light plant here, has sold the plant and property to Pittsburg capitalists in consideration of $10,000.

PHILADELPHIA.—The Michigan-Lake Superior Power Company is said to have in contemplation plans for improvements which will require the expenditure of about $800,000.

DOYLESTOWN.—The electric light and power plant of the Lehigh Power Company, located below Raubsville, is said to have been purchased by B. F. Fackenthal and Lee S. Clymer.

WERNERSVILLE.—The Wernersville Light, Heat & Power Company has been granted a charter to supply light to the Borough. The company has a capital of $5000, and among the stockholders are George W. Wertz, Robert W. Wertz and David Froelich.

RHODE ISLAND.

PROVIDENCE.—The Woonsocket Electric, Machine & Power Company has signed contracts whereby the company agrees to furnish electricity for twenty years to the Woonsocket Street Railway Company, the Columbian Street Railway Company, and the Burrillville Street Railway Company.

PROVIDENCE.—Walter I. Barnes, who for the past six years has been general superintendent of the Narragansett Electric Lighting Company, has taken the position of assistant general manager, recently made vacant by the resignation of Arthur B. Lisle. Mr. Barnes became identified with the Narragansett Electric Lighting Company thirteen years ago and was in the office of the treasurer for three years. Ten years ago he was transferred to the station on Elm Street, where he had charge of the generation and distribution of current and the purchase of supplies. It is understood that the company will expend in the near future about $200,000 in underground construction and the rewiring of houses on the East Side.

SOUTH CAROLINA.

GREENWOOD.—New electrical equipment is to be installed in the city water and electric light plant, it is said.

BAMBERG.—The citizens voted April 3 to grant to D. J. Howell and associates a franchise for water works and an electric light plant.

FLORENCE.—The Florence Electric Light & Power Company is arranging to furnish lights to Timmonsville. The company will also do commercial lighting in that town.

GREENVILLE.—A charter has been granted to the Saluda River Power Company with a capital of $300,000. It is proposed to develop power five miles from this city to supply textile and industrial enterprises. Lewis W. Parker, A. G. Furman and H. J. Haynesworth are the incorporators.

SOUTH DAKOTA.

MITCHELL.—The plant of the Electric Light Company has been sold to the Mitchell Gas Company for a consideration of $20,000.

GRAND FORKS.—The proposition to bond the city for $30,000, which has been under discussion here for some time, was decided at a recent election in favor of issuing the bonds.

TENNESSEE.

COOKEVILLE.—An electric light plant is to be installed here at a cost of $25,000.

DICKSON.—The citizens have voted to issue $6000 bonds for an electric light plant.

MEMPHIS.—The House is reported to have passed a bill providing for the municipal ownership of the lighting plant.

COLLIERVILLE.—Kirkpatrick & Johnson, of Jackson, Miss., have been selected to prepare plans for an electric light plant for this town.

DRESDEN.—The citizens have voted to issue $10,000 bonds for the establishment of a water works system and an electric light plant.

ATHENS.—It is reported that the Athens Light & Power Company has sold its plant to Long Brothers, who will make considerable additions to the equipment.

SHELBYVILLE.—There is reported to be a movement here looking to the purchase of the present water works and electric light plant by the town, or Council may decide to construct new plants.

TEXAS.

FORT WORTH.—The Bound Electric Company has succeeded to the business of the Broiles Electric Company.

SAN AUGUSTINE.—A. A. Sheffield is said to be interested in the construction of an electric light plant for this place.

FORT WORTH.—George W. Armstrong has secured a permit for the erection of a power house at a cost of $4,000.

BROWNSVILLE.—The People's Ice & Light Company has completed the ice plant and will begin the electric light plant at once.

SAN ANGELO.—U. G. Taylor, of this city, is reported to be interested in the construction of an electric light plant at Angelo Heights.

BARTLETT.—R. S. Decker has secured a franchise for the construction of an electric light plant and ground has been broken for the building.

FORT WORTH.—The Fort Worth Light & Power Company will soon begin the erection of a two-story brick store-room building, at a cost of $12,000.

McKINNEY.—The contract for constructing the municipal electric light plant has been let to the Hunter Electric Light Supply Company, of Dallas, for $6500.

BRADY.—The Brady Water & Light Company has been incorporated with a capital stock of $20,000. Among the incorporators are G. R. White and C. C. Baumgardner.

UTAH.

LOGAN.—Shepherd, Monson & Schaub have decided to install a power plant of 500 horse-power in Cache County.

FAIRVIEW.—The Fairview Electric Light & Power Company has filed articles of incorporation with the Secretary of State. The company has a capital of $15,000. Peter Olsen is president, and Peter Sundwale, secretary and treasurer.

VIRGINIA.

CAPE CHARLES.—I. J. Burbage, Town Clerk, writes that as no bids were received on April 3 for the electric light franchise the time for receiving them was extended sixty days.

LURAY.—The plant of the Luray Electric Company has been completed, and the company is prepared to supply 60-cycle, 110-volt alternating current for operating fans and motors.

WASHINGTON.

RITZVILLE.—C. O. Green has sold his electric light plant to N. H. and O. H. Green.

BALLARD.—The Ballard Electric Company has secured a new franchise and will make extensions to its plant.

HARRINGTON.—William Brodie and James Shaw, of Ritzville, have made application for a franchise for an electric light plant in this city.

SEATTLE.—The South Bend Electric Company, of which C. H. Kiehl is purchasing agent, is said to be in the market for an auxiliary steam plant.

KELSO.—The Kelso Water & Light Company has completed its water works and has secured a lighting franchise. It is proposed to construct an electric light plant at a cost of $10,000, but the company is not yet prepared to consider bids.

TACOMA.—The City Council has under consideration an offer from the Equitable Finance Company, of Portland, Ore., to construct a hydraulic power plant on Nisqually River, twenty-five miles from the city, to develop 5000 horse-power, the city to take the plant when completed.

ABERDEEN.—Plans are being drawn for extensive additions to the plant of the Grays Harbor Electric Lighting Company in East Aberdeen. The new building will be 45 x 96 feet and 22 feet high, with space for a 400-kw. turbine, the necessary boilers and other new machinery which the company has ordered.

WEST VIRGINIA.

KINGWOOD.—It is proposed to purchase a new dynamo for the electric light plant and install new wiring throughout the town. J. H. Kramer is chief electrician.

WHEELING.—The Dillonvale Heat, Light, Power & Water Company has been organized and has already purchased a site for the plant, which will be located on Piney Creek. The work of setting the poles and stringing the wires is well under way.

NORFOLK.—The Elkhorn Light & Power Company has been incorporated with a capital of $100,000 to own and operate power plants, to generate electricity for heating, lighting and power purposes; also to construct telephone and telegraph lines. J. J. Tierney and L. H. Clark are among the incorporators.

SISTERVILLE.—The Sisterville Light & Power Company has recently changed its circuits from a 133-cycle to a 60-cycle system. The company reports marked success in thawing out frozen water pipes electrically this past winter. Within a few weeks, over sixty services were operated on. As several of these were more than 100 feet in length and entirely underground, a considerable saving to the owner over the old method has been effected.

MARTINSBURG.—Capitalists of Washington and Baltimore are organizing a stock company for the purpose of purchasing the old pulp mills and water power at Harpers Ferry, where it is intended to erect a large electric light plant. It is said that $150,000 has been subscribed and that the venture is already assured. It is expected to make this plant a central point for supplying electric light to several cities and towns in the valley, and negotiations are under way with Winchester, Brunswick, Harper's Ferry, Charlestown, Hagerstown, Williamsport and other places.

WISCONSIN.

STOUGHTON.—The citizens voted April 3 to issue $25,000 bonds for a municipal lighting plant.

OSHKOSH.—The lighting contract for the city has been awarded to the Oshkosh Electric Light & Power Company.

JANESVILLE.—Bids are being considered for lighting the city with electricity for a period of five years from the 10th of July.

KENOSHA.—Mayor Gorman is reported to have begun a movement in this city to secure a municipal lighting plant. The present contract expires in two years.

MEDFORD.—Robert Mackenzie has resigned as manager of the plant of the Medford Light & Heat Company, Inc. and will be succeeded by William Johnson.

CADOTT.—The village of Boyd has granted a franchise to the Cadott Light & Power Company. The company will extend its line to that village in the near future.

BEAVER DAM.—The Beaver Dam Illuminating Company expects to install in its plant this summer a 100-kw., 60-cycle, alternating-current, direct-connected generating unit.

MILWAUKEE.—The Milwaukee Heat Light & Traction Company has increased its capital from $500,000 to $1,000,000. Most of the increase will be used for improvements.

MINOCQUA.—John Woodloch, of Merrill, owner of the electric light plant here, contemplates rebuilding the plant this coming summer, to include new dam, new water wheels, new dynamo and a new line five miles in length.

PLATTEVILLE.—The Platteville Electric Light & Power Company, recently organized, has filed an amendment to its articles of incorporation increasing its capital stock from $20,000 to $50,000. M. S. Sickle is president and J. H. Evans, secretary.

BERLIN.—The Berlin Lighting, Heating & Power Company has secured the contract for lighting the city for the next ten years. A 200-kw. generator and a 250- h.p. engine will probably be installed in the company's plant during the coming summer.

ONALASKA.—The City Council is considering the matter of electric lights. L. Stinson, of West Salem, has applied for a franchise, and if granted, he will build a plant on La Crosse River. The Wisconsin Light & Power Company, of La Crosse, has also made application for a franchise.

KAUKAUNA.—After May 1 the Kaukauna Electric Light Company will run both a day and night circuit and the city lighting will be done upon an all-night, every-night schedule. The water wheel capacity of the plant will also be increased and a direct-current power circuit, supplying 100 horse-power, has already been added.

MADISON.—The incorporation of the Wisconsin River Traction & Power Company and the Mathie Brothers Lumber Company is the beginning, it is said, of a large interurban-railway. water-power and paper-mill system. The former corporation, headed by Neal Brown, is capitalized at $30,000, and the latter at $90,000. Trappe City water power will be developed.

LA CROSSE.—Mr. Charles H. Williams, who has been with the Madison Gas & Electric Company, Madison, and who is president of the Northwestern Electrical Association, has resigned his position with the Gas & Electric Company to accept one as general manager of the Wisconsin Light & Power Company, of this place. The other officers of the company, which is a recent organization, are as follows: President, Henry A. Salzer; vice-president, J. J. Hogan; treasurer, G. Van Steenwyk; secretary, J. George Schweizer.

WYOMING.

CODY.—George T. Beck is pushing work very rapidly on the electric light plant, for which he was recently granted a franchise by the Town Council.

CANADA.

BRANDON, MAN.—Plans and specifications are being prepared for an electric light plant to light the streets and public buildings.

WESTMOUNT, QUE.—The Council has under consideration the construction of a municipal water works and an electric light plant.

QUEBEC, QUE.—The Quebec-Jacques-Cartier Electric Company is arranging to construct an additional dam in order to increase its power facilities.

SYDNEY, N. S.—The Council has decided to issue bonds to the amount of $60,000 for the purpose of constructing and equipping an electric light plant.

DUNCANS, B. C.—A by-law is to be submitted to the taxpayers of the city, empowering a company to install an electric light system during the coming summer.

ROSSLAND, B. C.—The West Kootenay Power & Light Company, of this city, has commenced an elaborate scheme of development of the upper falls of the Kootenay River at Bonnington.

CHARLOTTETOWN, P. E. I.—W. W. Clark, City Clerk, writes that it is proposed to apply to the Legislature for permission to construct an electric light plant at a probable cost of $75,000.

NORTH BAY, ONT.—The North Bay Light, Heat & Power Company has been organized recently, with a capital of $50,000, to generate and distribute electricity and gas for lighting and power purposes.

NIAGARA FALLS, ONT.—A bill has passed the Dominion Parliament granting permission to the Niagara & Welland Power Company to construct a power and ship canal from Welland Canal to Lake Ontario.

NEW GLASGOW, N. S.—A number of capitalists of Philadelphia are organizing a company for the purchase of the Edgerton Tramways Company, Ltd., and the New Glasgow Electric Light Company, both of this city.

INDIAN HEAD, N. W. TER.—The Council has been investigating the cost of constructing water works, a sewerage system and an electric light plant. John Galt, of Toronto, has submitted an estimate of $135,000 for the work.

QUEBEC, QUE.—The Quebec-Jacques Cartier & Power Company is considering plans for the construction of a dam on Montmorency River at the foot of the Natural Steps; it will be 90 feet high, 12 feet wide at the top and 65 feet wide at the bottom.

EBURNE, B. C.—Dalton & Everleigh are preparing plans for the new sub-station to be erected at this place at a cost of $40,000. The electrical equipment will have a capacity of 1000 horse-power. Nearly fifty miles of copper wire have been ordered at a cost of $45,000.

VICTORIA, B. C.—The electric light committee has presented a report to the City Council recommending the purchase of the following machinery: One new 230-light dynamo; one exciter; a new switchboard; three 50-light transformers; one belt, pulley and accessories, and new arc lights to the value of $4500.

TORONTO, ONT.—The Ontario & Minnesota Power Company has been incorporated, with a capital of $3,000,000, by W. E. Backus, of Minneapolis, Minn.; R. A. Grant, an attorney, of Toronto, and others, to develop water and other power for the transmission of electricity. The principal office is to be at Toronto.

GRAND FALLS, B. C.—The Grand Falls Power Company has been incorporated with a capital of $200,000, by Sir William C. Van Horne, of Montreal; Hugh Havelock MacLean, St. John, N. B.; Frank C. Partridge, Proctor, Vt., and others, to construct, equip, maintain and operate a canal and hydraulic raceway at Grand Falls.

CALGARY, N. W. TER.—The contracts for constructing an electric light plant for the city have been awarded as follows: Two Babcock & Wilcox 250-h.p. boilers with feed pumps and set up complete, Babcock & Wilcox, for $13,150; for a 350-h.p. compound Corliss engine, with condenser, heater, etc., to the Robb Engineering Company. for $9,574.

TORONTO, ONT.—At the annual meeting of the Toronto Electric Light Company the report of the president showed that the income of the company for the past year was $752,315, and the expenses, including interest on debentures, amounted to $450,273, which left a balance of profit of $302,041, out of which were paid four quarterly dividends at the rate of 7 per cent per annum, amounting to $187,965, leaving a balance of $114,076 to be carried forward to the credit of profit and loss. A reserve account has been created, and $300,000 has been transferred from profit and loss for that purpose. Considerable expenditures have been made looking toward the utilization of power from Niagara Falls, including underground conduits and cables.

MEXICO.

ABOL GRANDE.—The Agencia Commercial y Maritima will install an electric light plant here.

TEMASCALTEPEC.—Francisco Segura & Bro. will install an electric light and power plant at this place.

NUEVO LAREDO.—A company has been formed by Octaviano Gonzalez and associates, with a capital of $30,000, to construct an electric light plant here.

LAMPAZOS.—Arthur E. Banks, of Monterey, will install an electric light and power plant in this city. The plant will have an initial capacity of about 1000 incandescent lights, besides a number of arc lights.

XICOTLACOTLA.—Samson Lang has obtained a concession from the government authorizing him to utilize water from Amacuzac River, in the district of Jojutla, State of Morelos. The quantity granted is up to 78,000 liters per second, to be used for motive power.

CITY OF MEXICO.—The San Lorenzo waterfall, situated near Parral, has been purchased by James Roberts of the city of Durango. It is the intention of Mr. Roberts to establish a large electric power-transmission plant at the falls and to furnish power for mines and other industries. He paid $400,000 for the waterfall.

TLAXCALA.—The Aldermen of this city and the Governor of the State, Colonel Cahuantzi, are constructing a hydraulic plant near here which will develop 3000 horse-power. The power will be applied to various industries to be established near this city. The work was commenced about two years ago and over $50,000 has been already expended on it.

CITY OF MEXICO.—Col. W. C. Greene, the copper magnate of New York and Cananea, Mexico, is pushing forward his plans for building a large electric power plant on the Aros River, near the new town of Dedrick, which he is establishing. The line will be about 150 miles long, it is said. It is estimated that 30,000 horse-power can be developed by the water of the river at the point where the generating plant is to be located.

ZAPOTLAN.—It is announced that the steam-power electric lighting plant of the city of Zapotlan, which now furnishes 1500 electric lights and is capitalized at $96,000, has been acquired by a company composed of Rafael Arias, D. Villanueva and Ugarte & Fuentes, electrical engineers of the city of Guadalajara. The new owners will install a large plant to generate electrical energy by means of water power. The plant will be located at the Piedras Negras falls of the Covianas River, 16 miles from Zapotlan.

MONTEREY.—The Monterey Electric & Gas Company has been incorporated under the Canadian laws, with a capital of $3,000,000, for the purpose of conducting extensive electric lighting and traction business in and around Monterey, the capital of Nuevo Leon, Mexico, and one of the most important manufacturing cities in the southern republic. Interests largely identified with the powerful Canadian syndicate, which is primarily concerned in the Sao Paulo (Brazil) Tramway Light & Power Company, the Havana (Cuba) Electric Railway Company, the West India Electric Company, Limited, of Kingston, Jamaica; the Trinidad Electric Company, of Port au Spain, Trinidad, British West Indies; the Mexican Light & Power Company, Limited, and the Rio Janeiro (Brazil) Tramway Light & Power Company, Limited, are behind the new enterprise. The incorporators of the company are William Mackenzie, who is president of the Toronto Railway Company, the Sao Paulo Tramway Light & Power Company, and Mr. William Laidlaw, Z. A. Lash and A. W. Mack, all of Toronto, and Mr. H. S. Holt, of Montreal. Negotiations are now being conducted with the Monterey Light & Power Company, Limited, regarding the taking over of that concern's property by the Canadian company. The Monterey Light & Power Company operates an extensive lighting system in Monterey. The company is controlled by J. G. White & Company and H. W. Halsey & Company, of New York, Mr. P. G. Gossler, vice-president of J. G. White & Company, being president of the company, while Mr. H. R. Tobey, of the Halsey banking house, acts as secretary and treasurer. The chief engineer of the company is Mr Emilio Dysterud. The capital of the company is $500,000. The Canadian company has already contracted for the purchase of the existing horse car lines in Monterey, and what is known as the Mackin & Dillon concession. originally granted to the American contracting concern of that name. The purchase price is $450,000 gold. Thirty miles of electric road will be built in the first instance and construction will begin immediately, it is said. Mr Keating, of Toronto, will have charge of the work.

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ELECTRIC TRANSMISSION AND DISTRIBUTION IN NEW ENGLAND

STATIONS OF THE CONNECTICUT RAILWAY & LIGHTING COMPANY AT WATERBURY, CONNECTICUT.

The distances over which water power is electrically transmitted in New England are, as a rule, moderate. When compared with the transmission lines of California they become quite insignificant so far as distances are concerned, and unlike these notable systems, the water power stations of New England have to deal with rather low heads of water.

The hydroelectric station of the New Milford Power Company at Bulls Bridge on the Housatonic River in the town of Kent, Conn., has the distinction of being the largest electric generating station using water power in New England. It possesses the largest head of water, the highest transmission voltage and the longest transmission line of any of the many hydroelectric stations in New England, while in point of capacity it exceeds any of the famous water power stations of California, save that at Electra and Colgate.

Bulls Bridge is the site of a highway crossing over the Housatonic River, and is in that part of the valley where the river has a continuous rapid descent with steep, rocky hills close on either side. Near the bridge the valley narrows and the river has cut its way down into solid rock. Below the bridge the river makes a turn of nearly 90°, and then, after flowing nearly straight for about a mile, takes another turn that brings its general direction back to within a small angle of its former course. At a short distance above the bridge, a dam has been built across the river, and a canal starting from one end of the dam skirts the hillside for a distance of about two miles and then terminates in a forebay, where the water stands 110 feet above the surface of the river below the second bend just mentioned. From this forebay a steel pipe carries the water down the steep hillside to the power-house on the river bank. This type of water-power development, comprising a rather long canal, a moderate volume of water and a gradual fall in a river concentrated at a single point, so as to give a head of one to several hundred feet, is quite common in California, but has seldom been attempted in New England.

FIG. I.—GENERAL VIEW OF THE TRANSFORMER ROOM OF WATERBURY SUB-STATION NO. I.

The steel pipe leading from the fore-

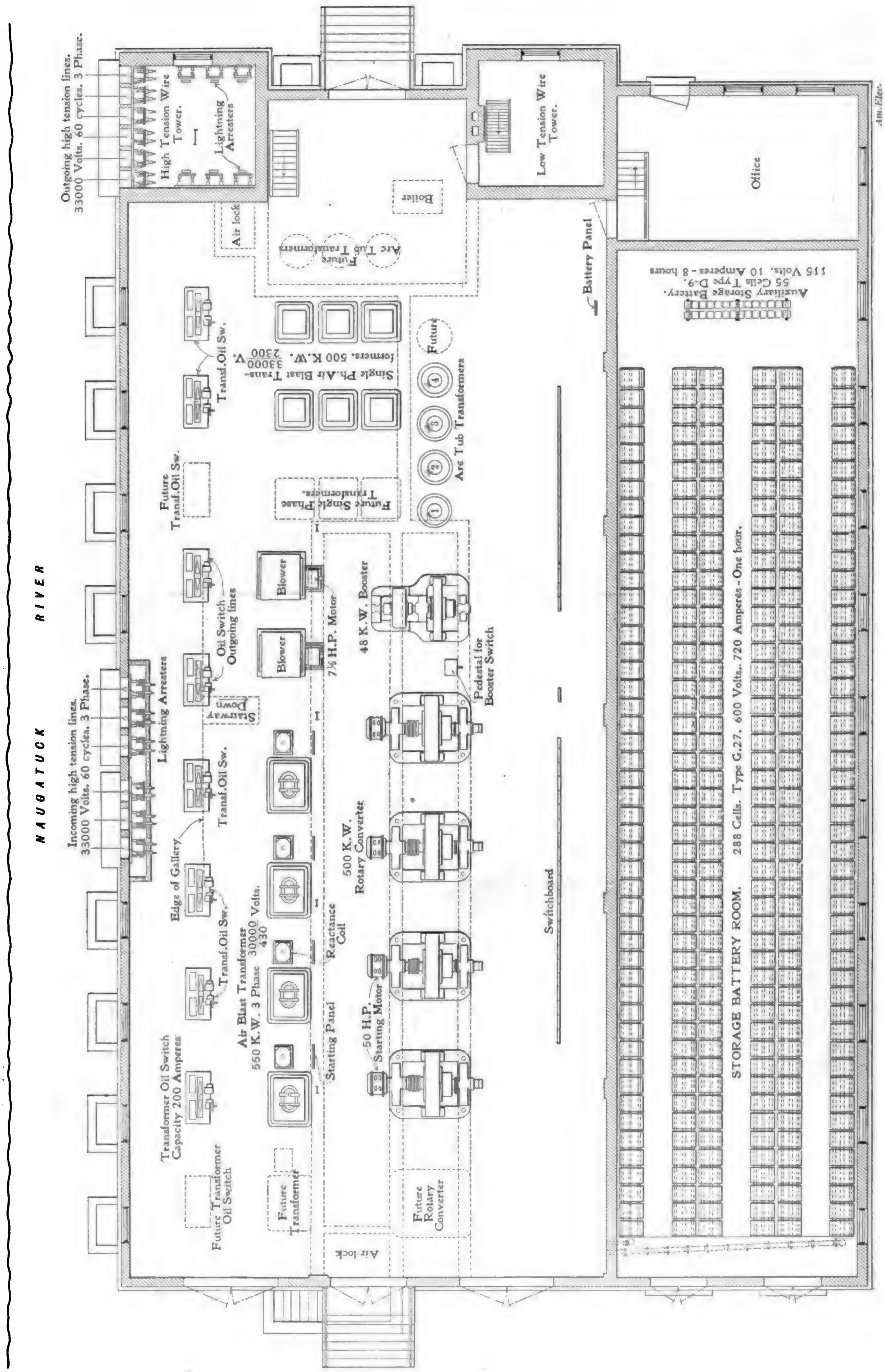


FIG. 2.—PLAN VIEW SHOWING LAY-OUT OF APPARATUS IN WATERBURY SUB-STATION NO. 1.

bay is 13 feet in diameter, and another pipe 8 feet in diameter will subsequently be erected. This 13-ft. pipe after reaching the power-house runs along outside of its river front, and connects with seven smaller pipes that pass through the wall to the water-wheels inside. At the end of this horizontal section of the main pipe, which shrinks in diameter as pipes from the wheels are taken off, it turns into a vertical position and extends to an elevation equal to that of the crest of the main dam. The stand pipe thus formed acts to relieve any undue pressure such as might be caused by the hydraulic ram action following the shutting down of some water-wheels too quickly.

The power house is built entirely of concrete and steel, the foundation being carried to solid rock. The station is formed into one main building 115 feet long by 48 feet wide with an annex in the rear and at the center 44 feet by 48 feet. In the main building are placed the wheel cases, hydraulic valves, governors, generators and exciters; while in the annex forming a part of the main building are found the switchboard, oil switches and electrical connections. In the rear of the annex and separated by a concrete partition wall a space 18 feet by 48 feet is devoted to transformers and lightning arresters.

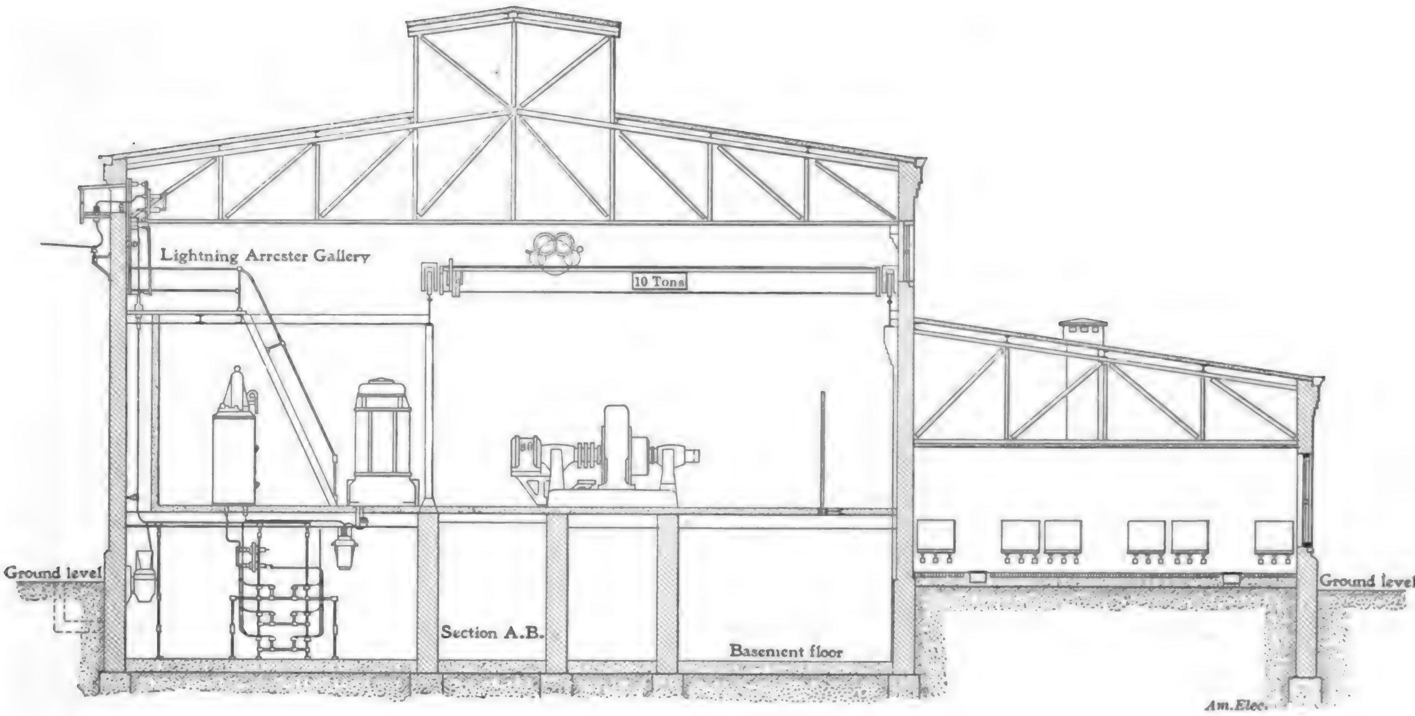


FIG. 3.—CROSS-SECTIONAL ELEVATION OF WATERBURY SUB-STATION NO. I.

The water wheels used are of the most recent high-speed type made by the Platt

FIG. 4.—HIGH-TENSION AIR-BLAST TRANSFORMERS.

FIG. 5.—MOTOR-DRIVEN HIGH-TENSION OIL SWITCHES.

Iron Works Company, of Dayton, Ohio. They are 31 inches in diameter and are placed tandem, being direct-connected to the generators and governed by Lombard water-wheel governors. Each pair of wheels has a capacity of 1750 horse-power, making a total for the six units installed of 10,500 horse-power. The three-phase generators have a capacity of 1000 kilowatts each and furnish current at 60 cycles and 1150 volts. They possess a momentary overload capacity of 50 per cent and a guaranteed overload capacity for several hours of 25 per cent. The voltage is stepped up in six oil-cooled transformers in banks of three to 33,500 volts for transmission.

The energy from this water power plant is used on the extensive system of the Connecticut Railway & Lighting Company in Waterbury, New Britain and Cheshire. Two sub-stations are located in Waterbury from which electricity is supplied to all of the street railway lines, as well as to power

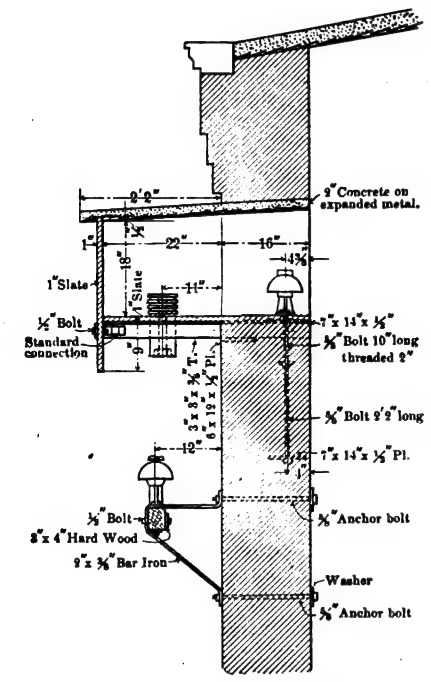


FIG. 6.—DETAIL OF OUTGOING HIGH-TENSION LINE ANCHORAGE.

and lighting circuits. The sub-station in New Britain is somewhat similar to the large sub-station in Waterbury in equipment and feeds street railway, light and power circuits. The sub-station at Cheshire is devoted exclusively to street railway work.

Two three-phase transmission lines from Bulls Bridge run to sub-station No. 1 of the Connecticut Railway & Lighting Company at Waterbury, Conn. The station is located on the west bank of the Naugatuck River on the outskirts of the town. Each of these three-phase circuits is made up of three bare aluminum wires having a conductivity equivalent to No. 00 copper. Energy delivered to the line at Bulls Bridge at about 33,500 volts reaches sub-station No. 1 at Waterbury over 30 miles distant with a loss ranging from 4 per cent to 7 per cent, depending on atmospheric conditions, being greatest of course during wet weather. Transformers at this station reduce the voltage to 2300 for overhead transmission through Waterbury to sub-station No. 2, situated in the center of the town. Current at a potential of 33,000 volts is also transmitted through the Waterbury sub-station, where switches are provided, to the sub-stations at New Britain and Cheshire, thus giving a transmission circuit over 40 miles long, making this the longest in New England.

The high-tension transmission lines run across a varied country. Wooden poles are used because of the cheapness of native timber, the cross-arms being also of wood with brown porcelain insulators. The wires are placed in the form of an equilateral triangle. A telephone circuit is run on the same poles several feet below the main line, and frequent transpositions are made to nullify induction effects. The lines are carried in duplicate and on separate pole lines from Bulls Bridge to Waterbury, except on a short run, where the six wires are carried on a single pole line. The lines from Waterbury to New Britain are also in duplicate but are carried on a single pole line. The line to Cheshire is taken through a switch house outside New Britain and consists of a single pole line carrying a single three-phase circuit.

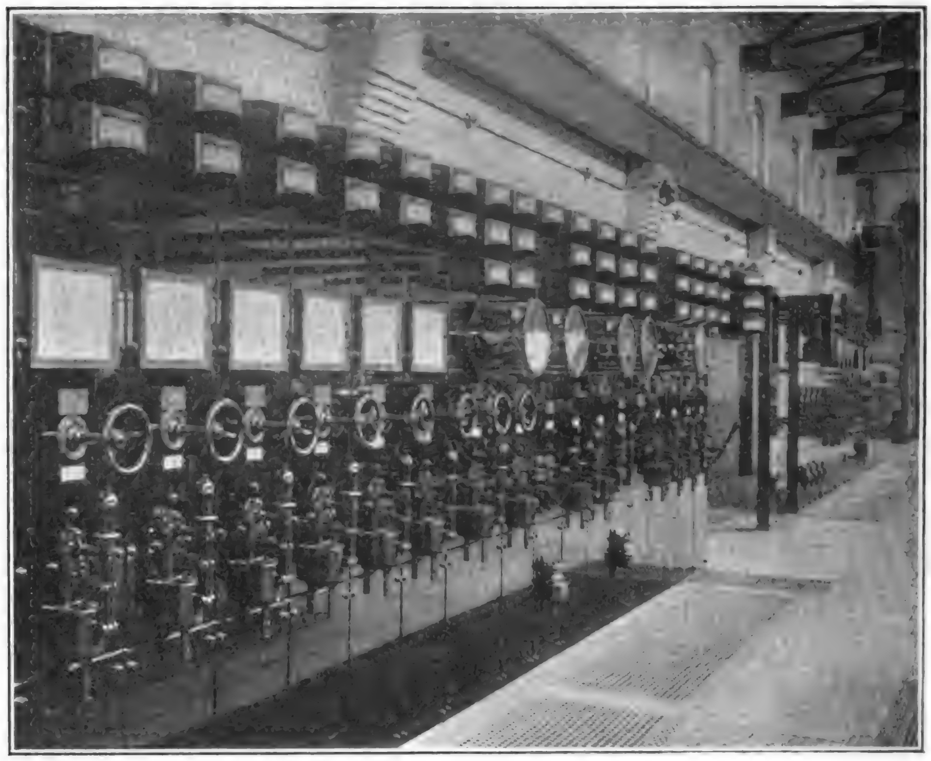


FIG. 7.—SWITCHBOARD, WATERBURY SUB-STATION NO. 1.

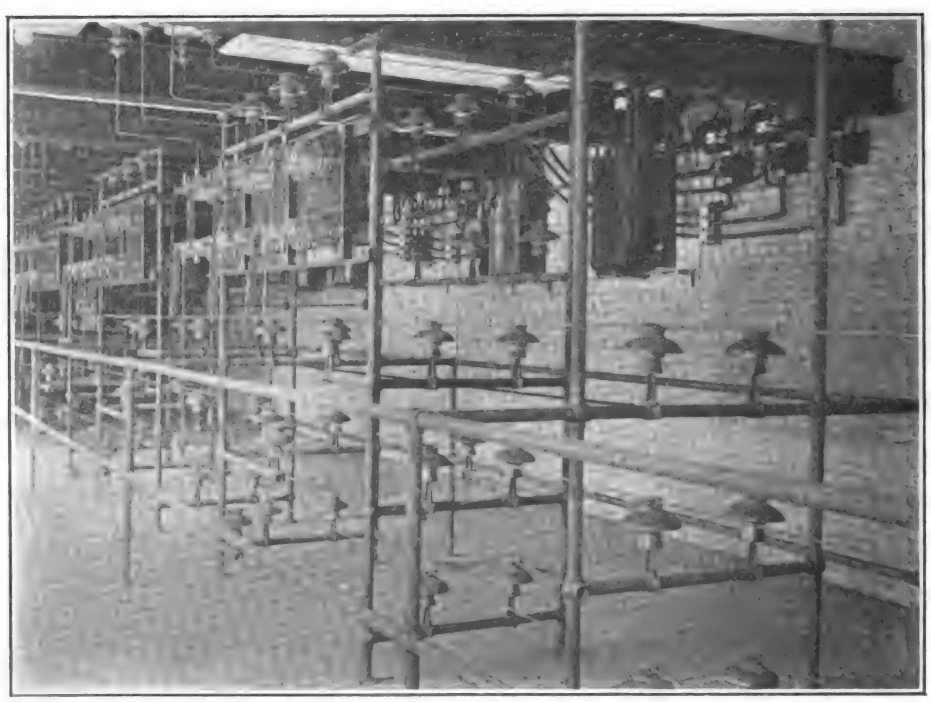


FIG. 8.—DUPLICATE HIGH-TENSION BUS-BARS IN BASEMENT OF SUB-STATION NO. 1.

FIG. 9.—ROTARY CONVERTERS IN WATERBURY SUB-STATION NO. I, ALTERNATING-CURRENT SIDE.

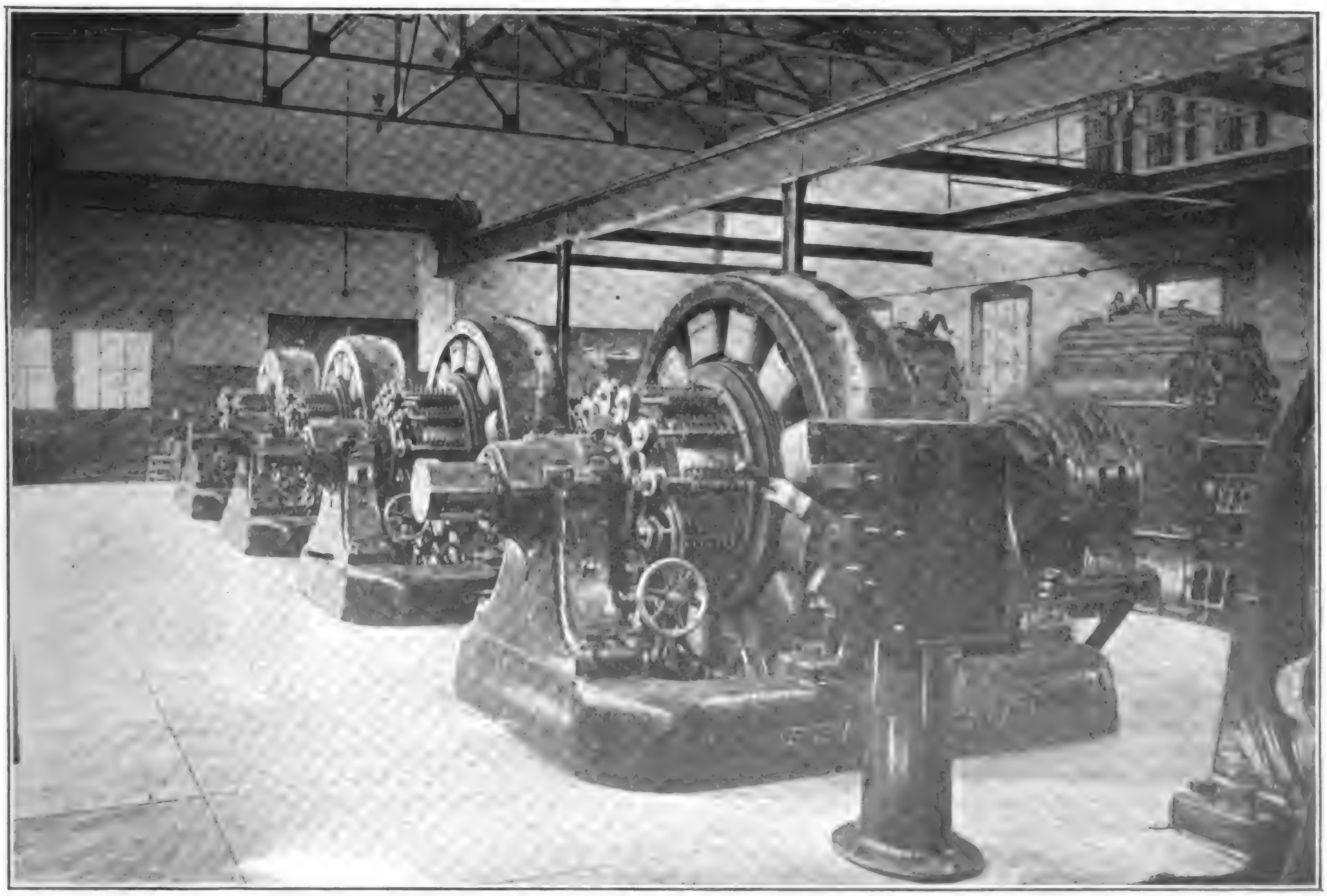


FIG. 10.—ROTARY CONVERTERS FROM DIRECT-CURRENT SIDE, WITH BOOSTER PEDESTAL SWITCH IN FOREGROUND.

Fig. 13 is a view taken from the east bank of the Naugatuck River at Waterbury and shows the incoming and outgoing high-tension transmission lines as well as the anchorages on the station building on the opposite side of the river. Fig. 6 is a detail view of the outgoing high-tension anchorage, the incoming high-tension anchorage being almost identical. Projecting two feet two inches from the wall of the the center of the pin are 8-inch porcelain insulators, one in line with each floor tube. Thirty-four inches below the slate floor of this shield and 12 inches from the wall are two 5½ ft. pieces of hardwood 3 ins. by 4 ins. in cross-section held in position by 2 in. by ⅜ in. bar-iron brackets fastened to the wall by ⅝ in. anchor bolts. Each piece of wood has fastened to it three 9-in. insulators, one immediately below each floor thence under the floor to the rotaries.

The ground area of the large sub-station in Waterbury, known as sub-station No. 1, is 125 feet by 78 feet, and its elevation includes a high basement and main operating room or first floor above, together with a somewhat lower structure running along the side as shown by the sectional elevation in Fig. 3. From ground to coping the height of the station is 28 feet;

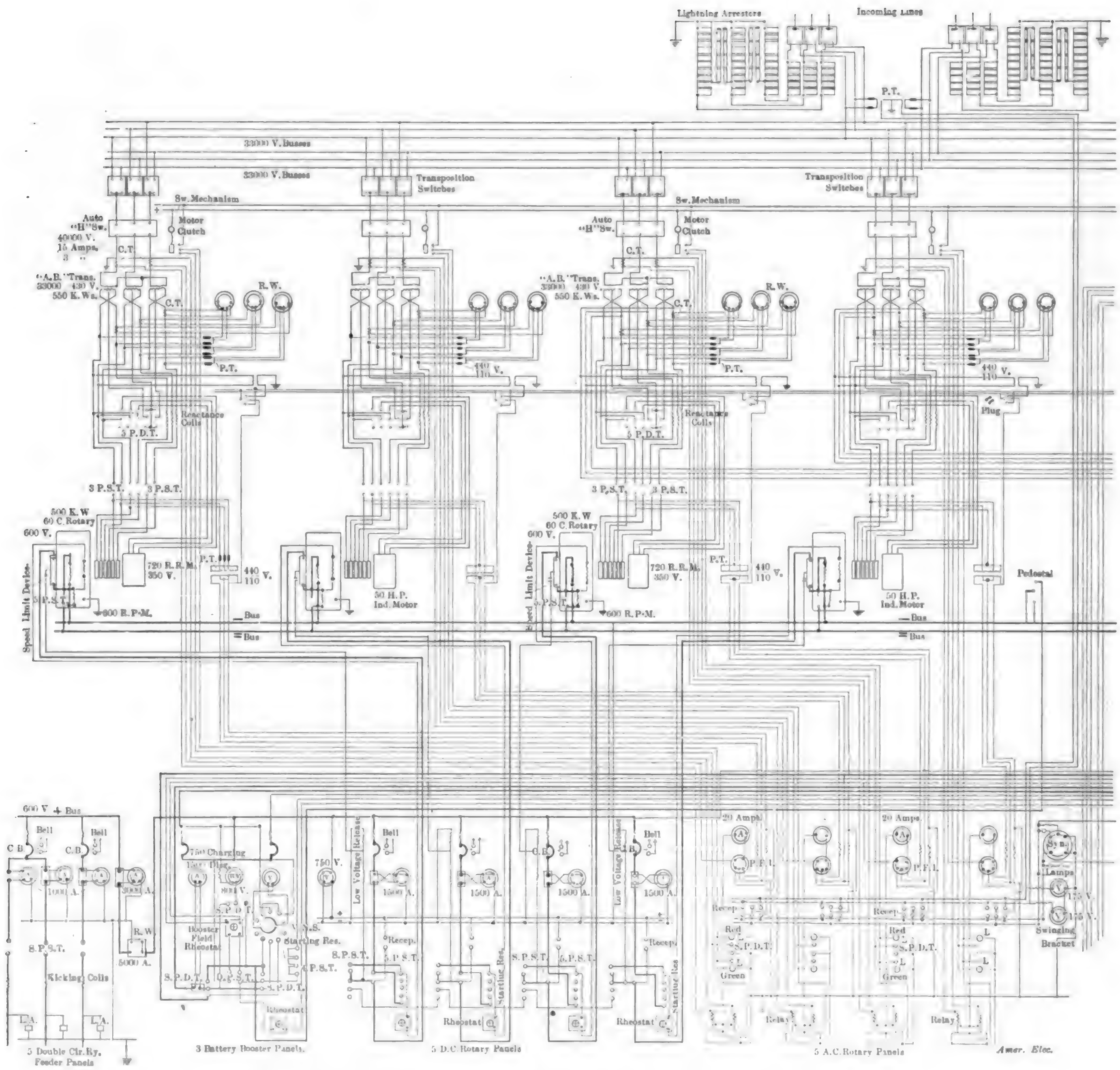


FIG. 11.—DIAGRAM OF SWITCHBOARD CONNECTIONS, WATERBURY SUB-STATION NO. 1.

high-tension tower and running almost the entire width is a weather shield having a roof of concrete on expanded metal, with one inch slate sides and ends projecting downward a distance of 27 ins. Eighteen inches below the roof of this projection and supported on T-iron extensions is a slab of one-inch slate completely closing the shield. This slab is pierced by six porcelain floor tubes placed 26 ins. apart and in a line 11 inches from the building wall to the center of the tubes. Resting in 22-inch openings in the wall, 4⅜ ins. from the inner side to tube. The insulators in the wall are separated by a 4-in. partition.

After passing through the weather shield and openings in the wall the six bare wires of the transmission circuits enter single-throw double-blade knife switches which connect each wire with a bank of lightning arresters and with duplicate 33,000 volt bus-bars in the basement. Double-blade jack-knife switches tap these bus-bars and connect them with 30,000-volt motor-driven oil-break switches. From here the circuit leads to 550-kw. three-phase transformers and from basement to main floor the distance is 10 feet, while the distance from the main floor to the lower cord of the steel roof trusses is 18½ feet.

In structure the sub-station is of brick, concrete and steel. The walls are 12 inches thick, which is increased to 16 inches at buttresses. The basement floor is formed of a one-inch layer of cement on nine inches of concrete, and the main floor is composed of concrete arches resting on steel I-beams and all supported by the outer and by 16-in. interior walls. The floor of

the adjacent room, which is used as a storage battery room, is composed of six inches of concrete covered with four and one-half inches of vitrified brick. Two towers, one on either side of the main building, as shown in the plan view, Fig. 2, 40 feet high with an interior space 13 feet square, are used for high-tension and low-tension transmission wires, the tower nearest the river being used for high-tension wires. by brick abutments. A small gallery on the side nearest the river contains the lightning arresters and knife switches for the incoming high-tension lines. These pass directly to the basement, a narrow chamber formed by partition walls being provided for the purpose of isolating them from the main floor.

The air lock doors for the air-pressure chamber are 2¾ feet by 7 feet. They are has a ⅛-in. rubber gasket on each end. A 4-in. hole is provided in the door so that when the outer door of the air lock chamber has been shut this hole may be uncovered and the pressure on either side of the door equalized, thus permitting the door to be opened with ease. The hole is provided with a 1/16-in. rubber gasket and is covered with a heavy iron flap hinged at the top.

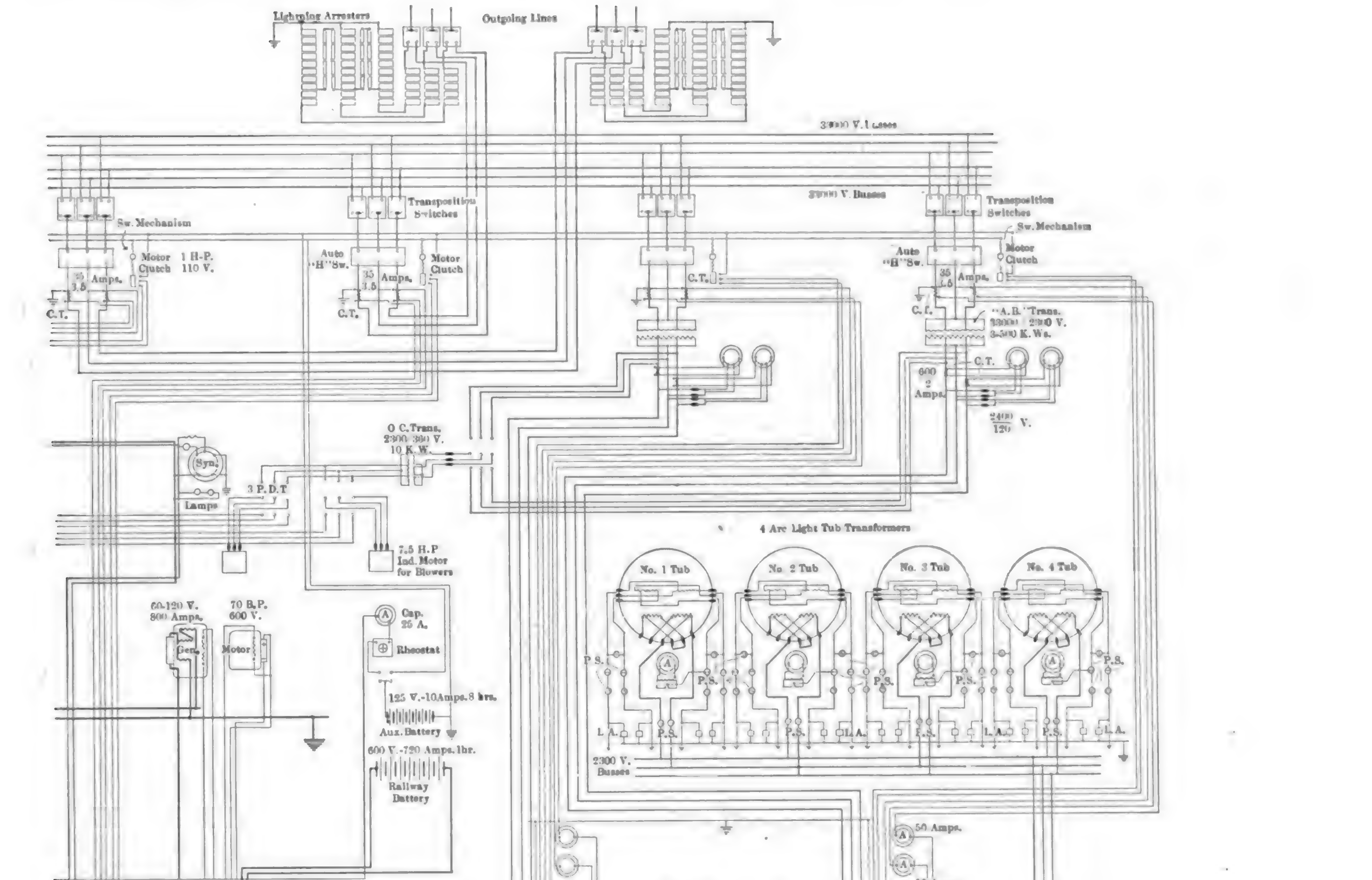


FIG. 12.—DIAGRAM OF SWITCHBOARD CONNECTIONS, WATERBURY SUB-STATION NO. 1.

The station is lighted by large windows along the sides and by windows in the monitor roof running along the center of the main building.

The basement is divided by 16-in. interior walls into spaces for air pressure chambers, bus-bar compartments and oil switch cells. The air pressure chamber is 19 feet wide and all high-tension bus-bars are located therein. The main floor, which is 113 feet long by 50 feet wide, is swept by a ten-ton traveling crane. The I-beams on the side walls of the station are supported made of 3/16-in. plate riveted to a 2-in. by 2-in. by 3/16-in. L-iron frame and hinged to the wall. The handle passes through the door and catches on the curved side of the angle of a 2½-in. by 2½-in. by ¼-in. L-iron frame fastened to the wall and against which the door shuts. A ⅜-in. rubber gasket is cemented to the angle of this frame around the entire surface and the pressure of the door against this gasket precludes the escape of air from the chamber. The door may be opened from either side and the bolt passing through the door

Fig 2 is a plain view of the sub-station showing the layout of the apparatus, and Figs. 9 and 10 show photographic views of the main transformer room. The equipment housed in this station consists of four 500-kw rotary converters, one 48-kw booster, four 550-kw, 33,000-volt, 60-cycle transformers with their reactance coils, eight motor-driven, high-tension oil switches, two motor-driven blowers, six single-phase transformers, six arc light transformers, a railway storage battery and an auxiliary storage battery, together with controlling

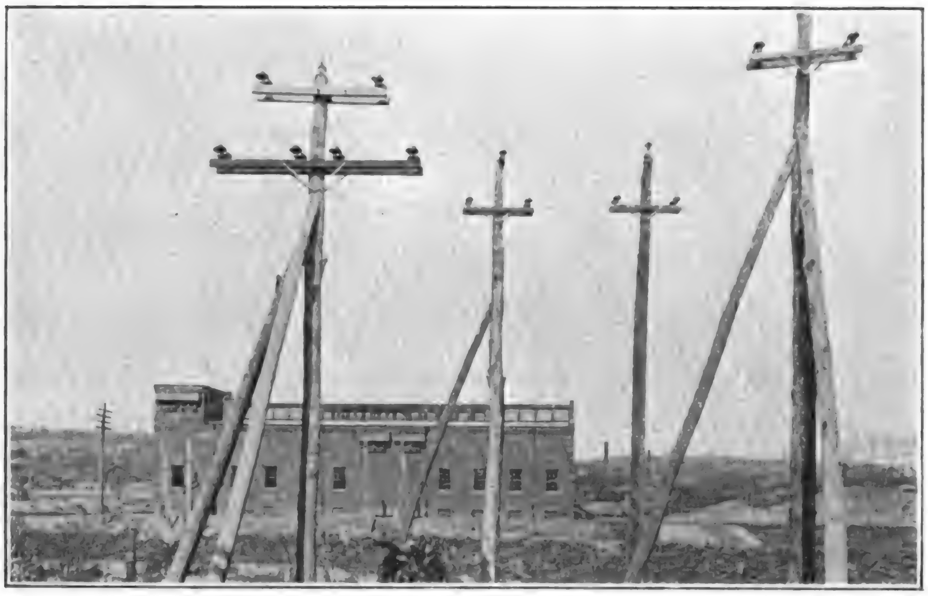


FIG. 13.—WATERBURY SUB-STATION NO. 1, SHOWING INCOMING AND OUTGOING HIGH-TENSION TRANSMISSION LINES.

switchboards. Space is provided as indicated for additional apparatus.

The transformers are all of the air blast type, the primary and secondary voltages of the 550-kw. units being 33,000 and 430, respectively. The primary and secondary voltages of the 500-kw., single-phase transformers are 33,000 and 2,300, respectively. The air pressure maintained in the chamber beneath the transformers is ⅝ oz. Two Buffalo Forge Company's fans, each direct-driven by a 350-volt, 60-cycle, 7½-h.p. induction motor, supply the air for the air pressure chamber. These units are located just beyond and in line with the large transformers about the center of the room and beside each induction motor is a switch panel carrying the necessary apparatus for throwing the motor into circuit.

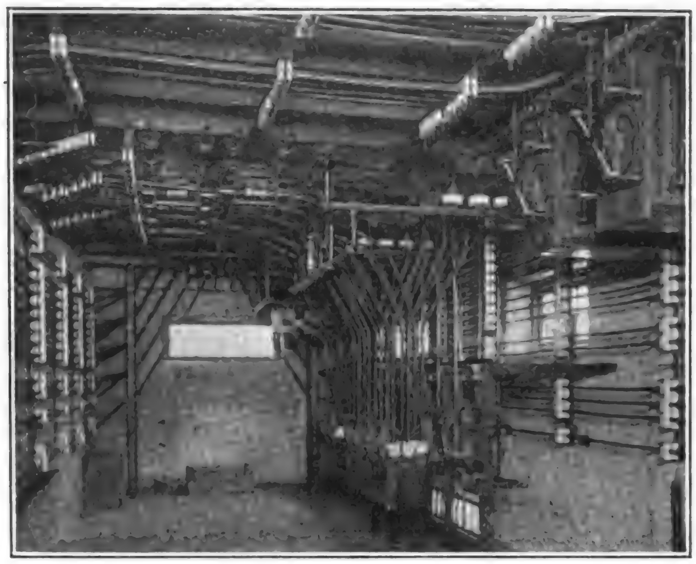


FIG. 14.—OIL SWITCHES AND REGULATORS IN BASEMENT OF SUB-STATION NO. 1.

The rotaries, of which there are four installed, are 60-cycle machines having twelve poles and running at 600 r.p.m. They each deliver 833 amperes of direct current at a potential of 600 volts. Each rotary is started from standstill by means of a 50-h.p. induction motor mounted upon the rotary converter shaft, and when the armature is thus brought up to synchronous speed connection is made to the alternating-current mains. Switches are provided for starting the rotaries as direct-current motors from the commutator end, but this method of starting is seldom if ever used. The current from the rotaries is used entirely for railway purposes, the maximum load of which is 2500 amperes, which comes on at noon.

The high - tension transformer oil switches have a capacity of 200 amperes at 30,000 volts. These switches are operated by direct-current series motors taking 11 amperes at 110 volts and running at 2,800 r.p.m. The operation of the oil switch may be accomplished by a small single-pole, double - throw, hand - controlling switch mounted on a panel of the main switchboard. Red and green lights indicate whether the oil switch is closed or open. Six breaks are provided in the triple-pole switch, each break taking place in a separate oil receptacle and in addition each phase is enclosed in a fireproof compartment. The cells are constructed of brick, with top and bottom slabs of slate. The switches installed are all automatic in operation, a relay operated by current transformers closing the direct-current operating motor circuit. Fig. 5 shows the line of large oil switches.

The six 500-kw. transformers are arranged in banks of three, and the 2,300-volt secondary current obained from them is transmitted over two separate trunk lines of No. 000 copper to sub-station No. 2 in the center of the town. The six constant-current transformers are used for series arc lighting; single-phase arc lighting circuits running to Naugatuck, North Willow and Highland Park, Waterville, East Waterbury, North Waterbury and Forest Park, Watertown, South Waterbury and Platt's Mill. The line to Watertown has a straight run of six miles before distribution is made. A three-phase feeder line also runs to Naugatuck, where it is split up into three single-phase circuits.

The storage battery used on the railway circuits consists of 288 type G-27 cells. The voltage is 600 and the rate of discharge is 720 amperes for one hour. The auxiliary storage battery consists of 55 type D-9 cells and the voltage is 110, with a discharge rate of 10 amperes for eight hours. This battery is used to supply current to the motors of the oil switches and pilots. The indescent lamps are wired five in

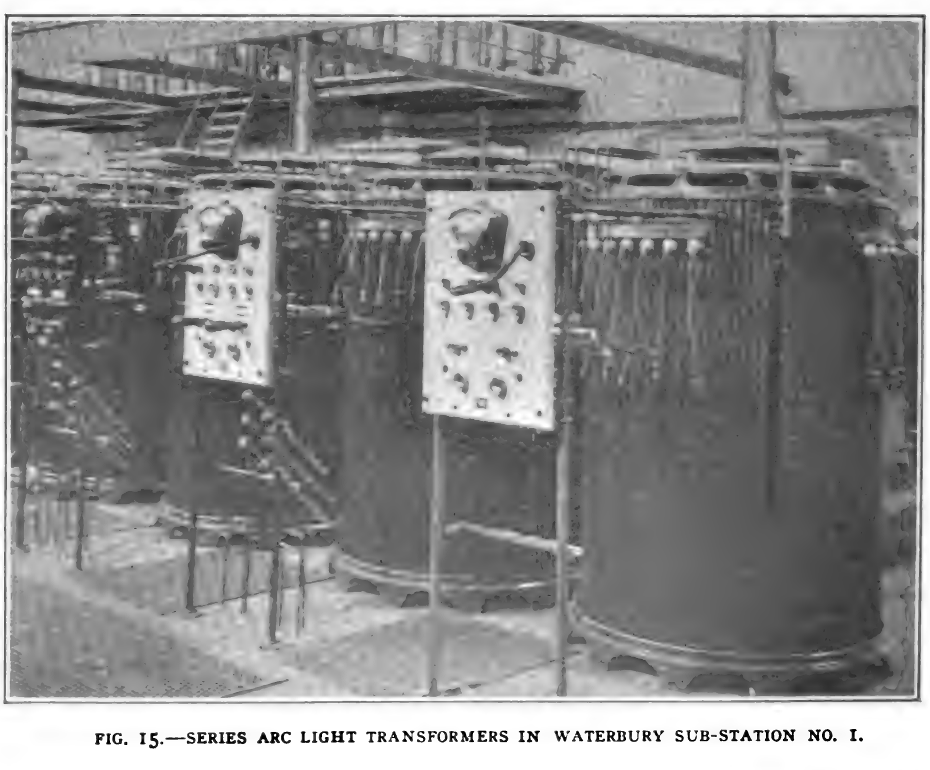


FIG. 15.—SERIES ARC LIGHT TRANSFORMERS IN WATERBURY SUB-STATION NO. 1.

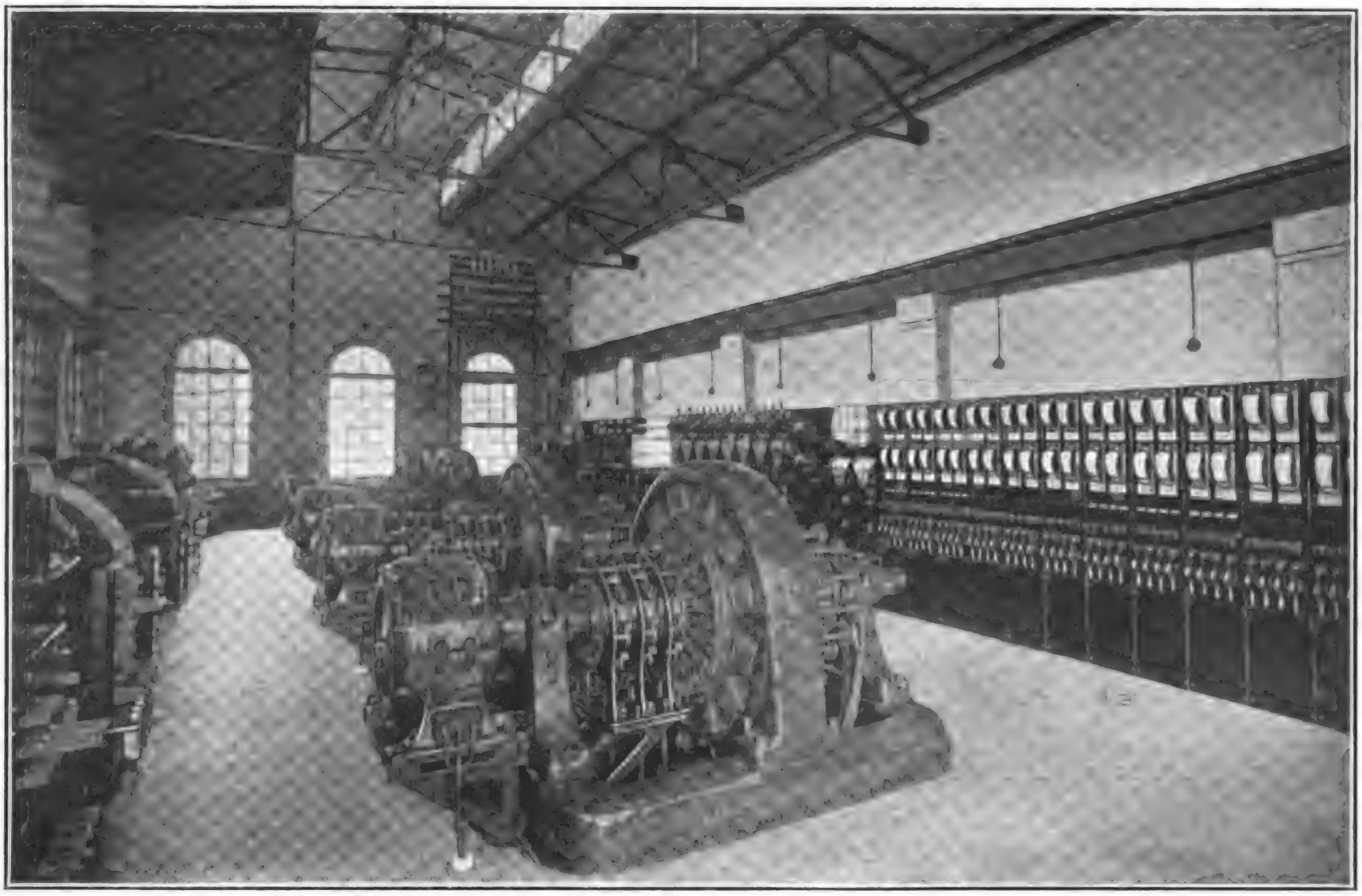


FIG. 16.—GENERAL VIEW OF THE INTERIOR OF WATERBURY SUB-STATION NO. 2.

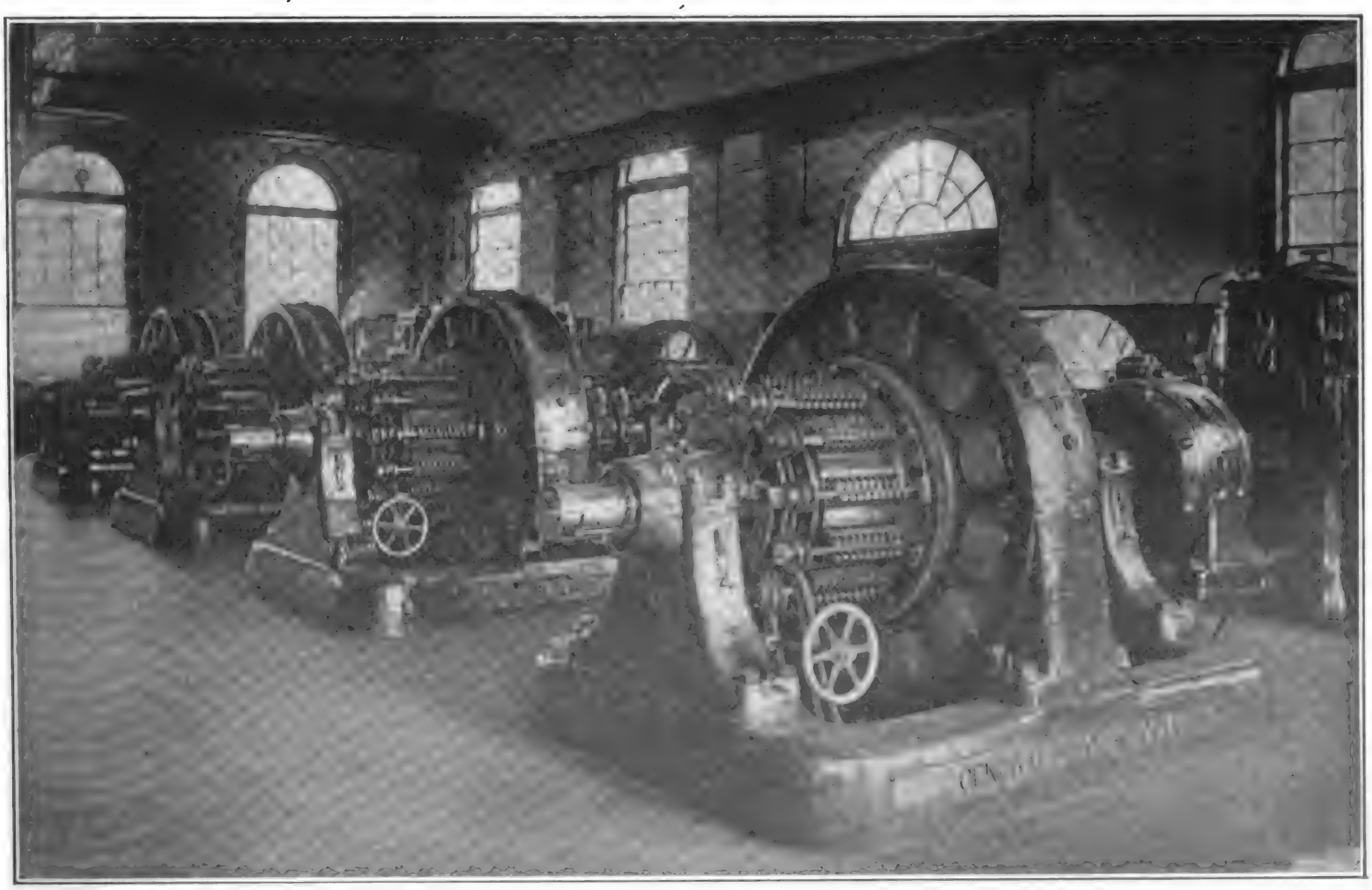


FIG. 17.—NEARER VIEW OF ROTARY CONVERTER S FROM THE DIRECT-CURRENT END.

series with a 2,300/500 volt transformer to a supply circuit. In case of shut down at New Milford a throw-over switch connects these circuits with the main storage battery so that the station will at no time be without light. The alternating-current enclosed arc lights with which the station is bountifully provided are fed from a separate 104-volt transformer circuit in the station.

A view of the switchboard is shown by Fig. 7 and a diagram of its connections cut in two for convenience of printing, is shown in Figs. 11 and 12. The board is made of black enameled slate and contains 40 panels, distributed as follows: Five double-circuit railway feeder panels, five single-circuit feeder panels, three battery-booster panels, four direct-current rotary panels, four three-phase power panels, two three-phase trunk line panels to sub-station No. 2, one totalizing panel for arc light circuits, one three-phase panel, six single-phase lighting panels and three sectioning panels. The circuit-breakers, ammeters, rheostats, hand-wheels, switches, etc., are of uniform design and occupy the same position on all panels thus giving a symmetrical appearance to the switchboard. The circuit-breakers on the railway feeder panels are equipped with a tell-tale device which completes the circuit of an alarm bell when the breaker opens. The device is automatically reset when the breaker is closed again. The circuit-breakers on the converter panels in addition to having this tell-tale device have low-voltage release coils which trip the breakers when the voltage drops below a certain point. The low-voltage release coil is used in connection with a centrifugal speed limiting switch mounted on the shaft of the rotary, and which short-circuits the low-voltage release coil and opens the circuit-breaker in case the speed exceeds the normal.

The panels controlling the 2,300-volt three-phase and single-phase circuits are grouped together, but the bus-bars are divided into four sections by three section switches, thereby giving great flexibility in the matter of connections. The power circuits, trunk-line circuits, arc-light circuits and incandescent circuits are all metered separately. Oil switches are used on these

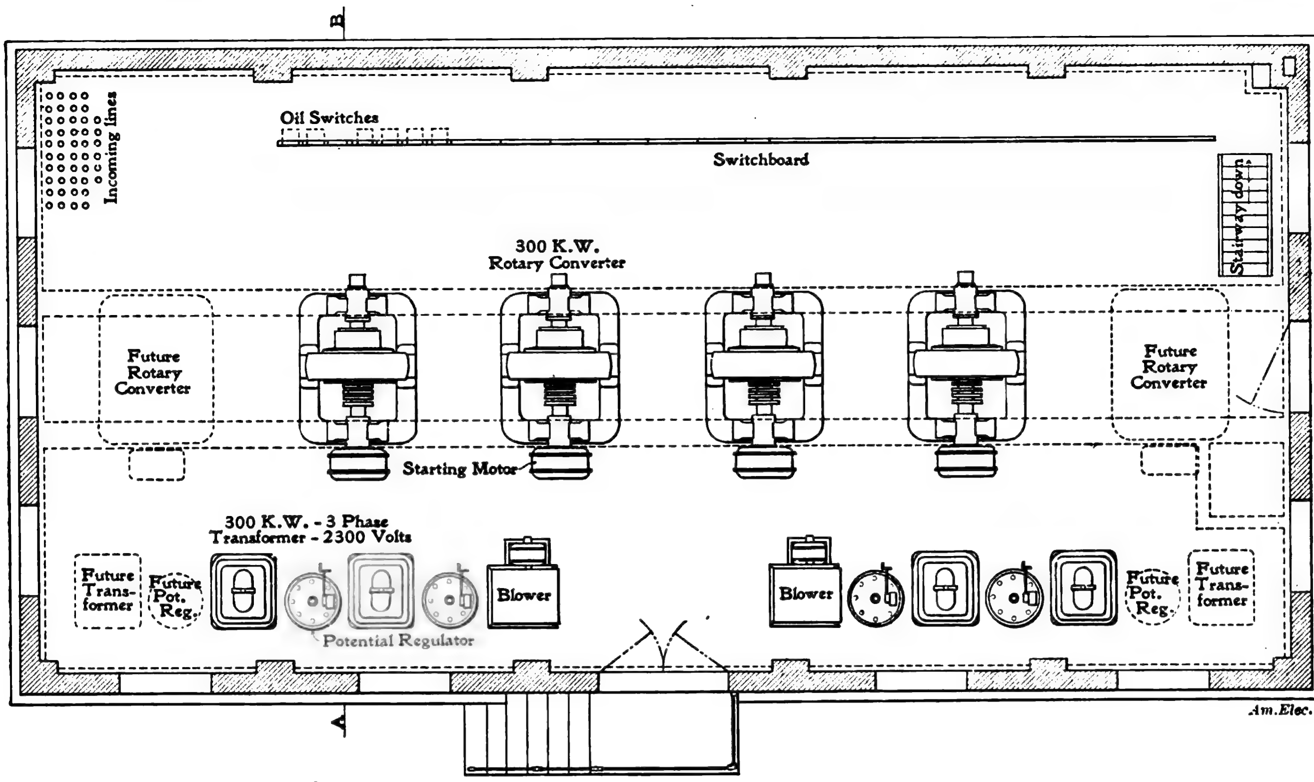


FIG. 18.—PLAN VIEW SHOWING LAY-OUT OF APPARATUS IN WATERBURY SUB-STATION NO. 2.

FIG. 19.—2300-VOLT AIR-BLAST TRANSFORMERS AND DIRECT-CURRENT, MOTOR-DRIVEN BLOWER.

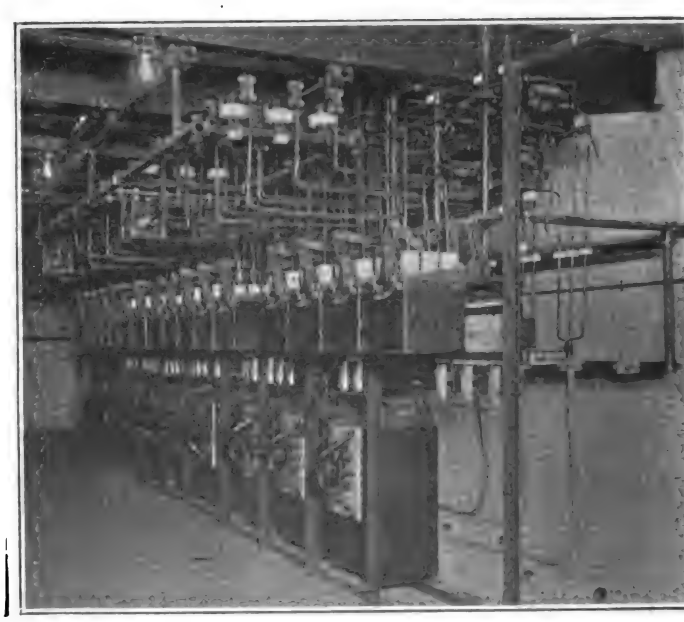


FIG. 20.—OIL SWITCHES, REGULATORS, ETC., IN WATERBURY SUB-STATION NO. 2.

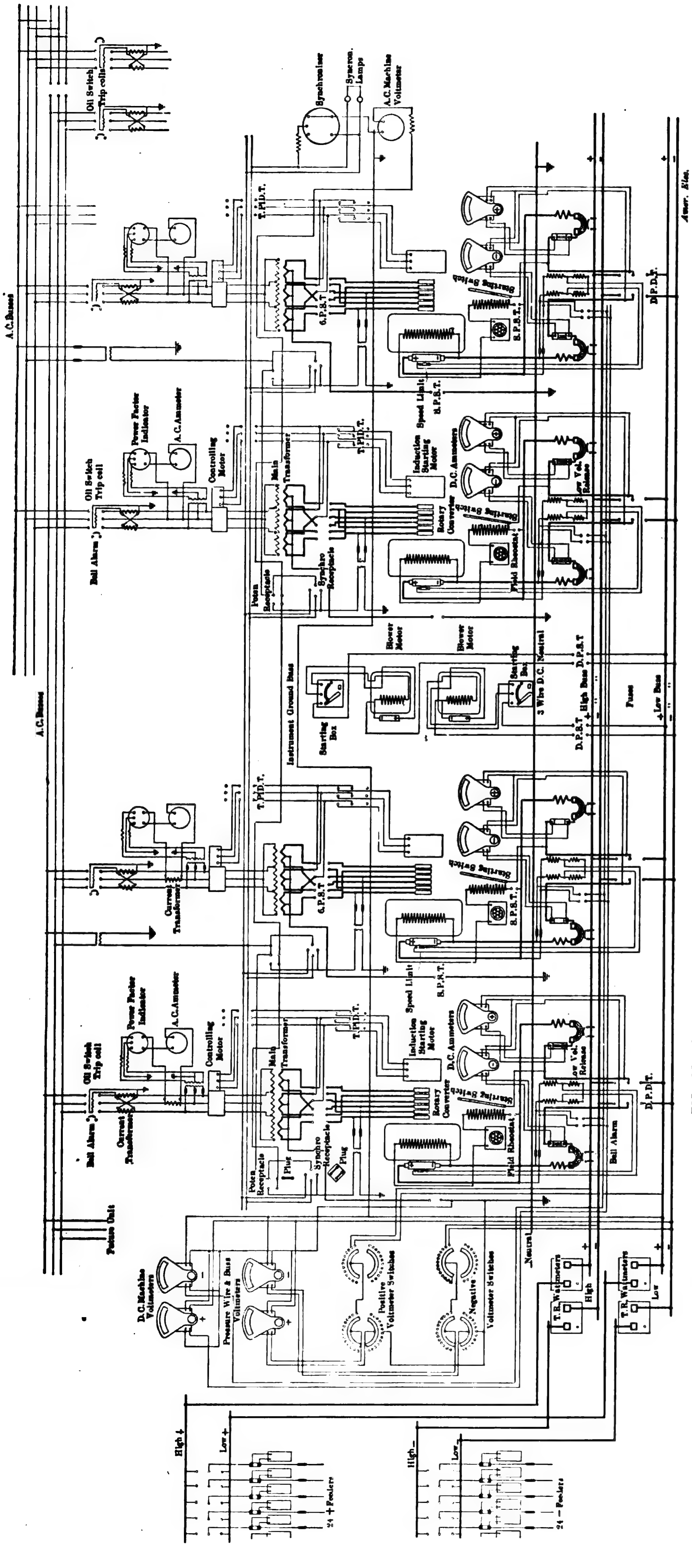


FIG. 21.—DIAGRAM OF SWITCHBOARD CONNECTIONS, WATERBURY SUB-STATION NO. 2.

panels, the operating mechanism being controlled by the switch through rods passing through the floor. Fig. 14 shows the oil cells and regulators in the basement beneath the switchboard. The oil switches are electrically tripped on overload, with the exception of the sectioning switches which are not equipped with the electrical releasing device. The device is shown clearly beneath the switches in the engraving of the switchbooard, Fig. 7. Practically all of the wiring is run in the basement, where ample room is provided in which to work. No wires carrying high-tension current are brought directly to the switchboard. 450 series arc lamps and about 30,000 incandescent lamps are fed from this station.

Sub-station No. 2 is somewhat smaller in size and equipment than the sub-station just described and covers an area 35 feet by 70 feet. A plan view of the station and its equipment is shown by Fig. 18, and Figs. 16 and 17 are photographic views of the rotaries. The incoming trunk lines from Sub-station No. 1 may be seen in the background of Fig. 16. These pass directly to the bus-bars and switches in the basement.

The equipment of the station consists of four 300-kw. rotary converters, with their starting motors, four 300-kw., three-phase transformers with potential regulators and two motor-driven fans together with a switchboard running along the side almost the entire length of the station. That portion of the basement beneath the transformers is laid out as an air-pressure chamber, while that portion below the switchboard contains the oil switches, busbars, regulators, etc., as shown in Fig. 20.

The converters are 60-cycle machines, running at 600 r.p.m. and delivering direct-current at 275 volts. They are brought up to speed by 30-h.p. induction motors, but may be started from the direct-current side also. Space is provided for additional machines. The transformers have a primary voltage of 2,300 volts and secondary voltage of 188 volts. The fans are of the Buffalo Forge Company's make and are driven by a 5-h.p., direct-current motor at 400 r.p.m. The air pressure maintained is ⅜ oz. Four I-T-R potential regulators are installed, each being operated by a ¼-h.p. induction motor. These regulate the alternating-current voltage delivered to the transformers. Almost all the regulation is obtained in this way, very little being possible from the direct-current end. The panel in front of each regulator contains a three-point, double-throw starting switch, a single-throw neutral switch and two double-pole, double-throw, alternating-current running switches.

The switchboard is shown in Fig. 22 and a diagram of its connections is shown by Fig. 21. It is equipped with high and low voltage bus-bars and the switches are double-throw, so that when thrown up they connect with the high voltage bus, and when thrown down they connect to the low-voltage bus. The high-voltage busbars are, however, not at present in use. The board contains 12 feeder panels, having 48 feeder switches, one-half of which

are only at present connected. The station is devoted entirely to power and lighting work on the Edison three-wire system.

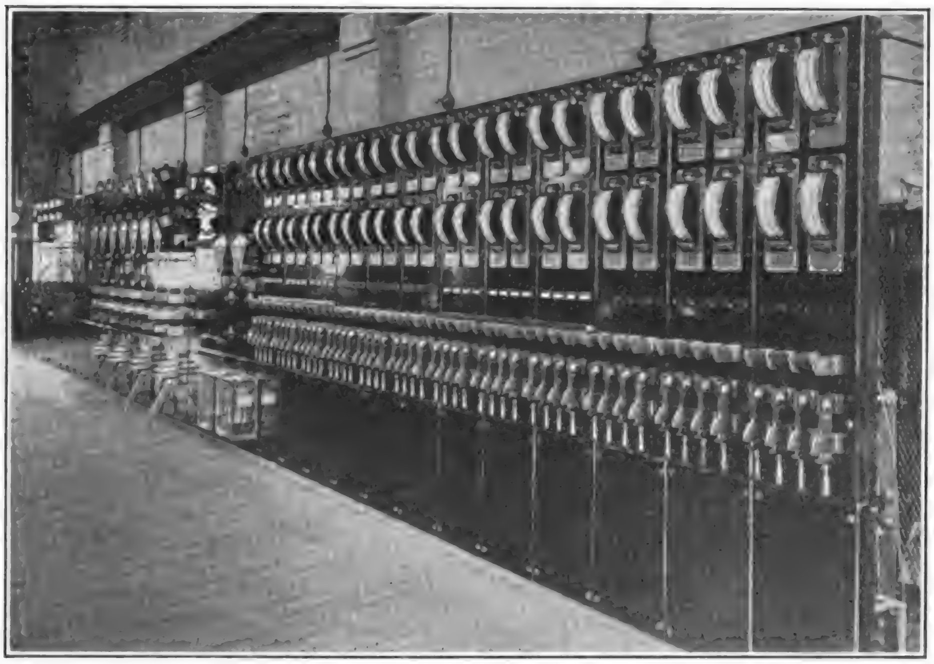


FIG. 22.—SWITCHBOARD, WATERBURY SUB-STATION NO. 2.

The territory fed by the station is about one square mile, the station being at about the center of the load. Overhead wires are at present used, but by the time this article appears, work will be commenced on an underground conduit system. The commercial multiple-arc lamps connected number abut 900 and the incandescent lamps number over 20,000. The entire electrical equipment of the Connecticut Railway & Lighting Company's sub-stations at Waterbury, including series and multiple arc lamps, as well as the electrical equipment of the New Milford Company's hydroelectric station at Bulls Bridge was supplied by the General Electric Company.

The load in Waterbury was previously carried by a steam-driven central station on Bank Street bordering on the Naugatuck River. This station is now maintained as a reserve in case of any accident to the transmission plant at Bulls Bridge; but this is so well guarded against that a failure of supply is almost impossible, and it will be only a matter of time when the old steam station will be dismantled. The superintendent of the Waterbury station is Mr. D. B. Neth, to whom we are indebted for many courtesies extended in the preparation of this article.

MOTOR-CONTROLLING APPARATUS.

BY FRANCIS W. APPLETON.

The development of the variable-speed motor has brought with it much improvement in the design and construction of motor-controlling apparatus, but there yet remains room for some improvement. The many automatic or semi-automatic motor starters now in use constitute a highly commendable step forward, and the combined starting and speed-regulating "boxes" which represent the latest development in this field are wonderfully complete in their functions and are reasonably reliable in service. It is undeniably true, however, that electrically operated mechanisms for starting motors from a distance have not been brought to the "irreducible minimum" of parts, nor do the electrical contacts in such appliances represent the final effort in the way of design.

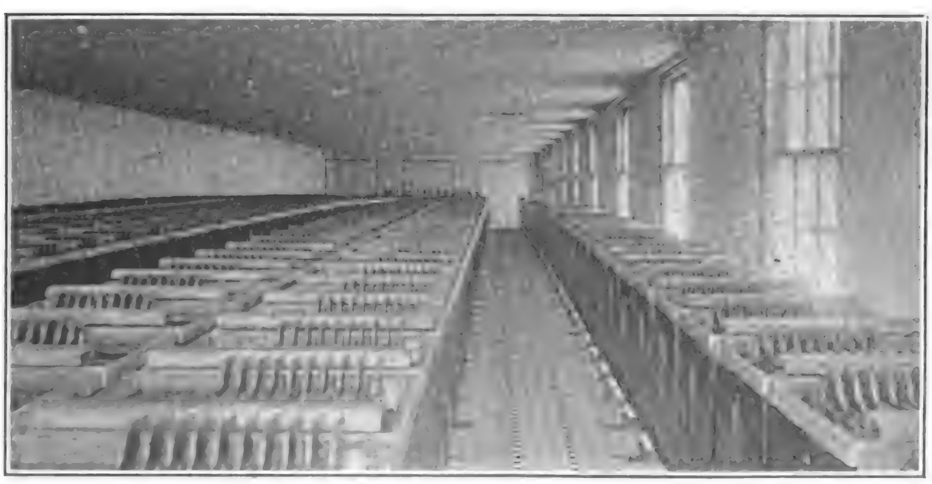


FIG. 23.—STORAGE-BATTERIES IN WATERBURY SUB-STATION NO. I.

Sliding contacts have the great advantage of keeping themselves mechanically clean—until arcing occurs; then they degenerate into the least reliable of all moving contacts. If made of carbon, to minimize the effects of arcing, they wear away very rapidly and very unevenly. On the other hand, butt contacts of carbon are not affected by ordinary arcing and their wear is trifling, but they are liable to accumulate dust and particles of charred carbon which seriously impair the efficiency of the contacts.

It would seem evident from the foregoing well-recognized facts that the nearest approach to perfection that is attainable in the present general "state of the art" in motor-controlling apparatus would be realized by the use of carbon butt contacts which have a slight sliding motion after coming into touch, with a leaf-copper yielding butt contact to short-circuit the carbons after the last one of the latter has closed. This is doubtless true, and the writer is strongly of the opinion that a motor-starter built on this fundamental idea will give more reliable service, with vastly less attention and repairs, than the old-fashioned sliding brush and row of contact plates or a series of metal butt contacts.

In order to make up a starting apparatus of the type just mentioned, it is necessary to use at least four or five expensive solenoid switches, together with an overload relay to open-circuit the switches at a predetermined load. Such an outfit is ideal from a purely engineering standpoint, but its cost is prohibitive in all cases except highly special ones, such as passenger elevators, printing presses, or large motors that must be started and stopped from a distance.

The writer recently saw in successful operation a crudely simple arrangement consisting of a number of carbon-faced contact fingers and a leaf-copper contact which, when closed, short-circuited all of the carbons after all of the armature resistance was cut out by them; a solenoid and a dashpot controlled these contacts, and a small relay magnet connected in series with the motor armature served to open the exciting circuit of the solenoid when the load reached a certain point beyond the rated ability of the motor. This outfit has been in active operation for eight months without a hitch, with no attention whatever, no renewal of contacts or other repairs having been found necessary; it starts a 35-h.p., 220-volt motor dozens of times daily, and the acceleration is smooth, without any sparking at the motor brushes and with practically no arcing at the carbons, except for the slight flash at the first carbon when the motor is cut off while under a heavy load.

The control of motor field excitation is a simpler matter than that of armature circuit, and for this class of work sliding contacts are less annoying; but an arrangement somewhat similar to that just described would undoubtedly prove far more satisfactory in all ordinary cases. The application of such an arrangement to the control

of a sectional conductor, whether inductive or not, confers the immense advantage that fewer divisions of the conductor are necessary than when sliding contacts are used, the operation of butt contacts being affected to only a negligible extent by arcing. For example, the motor starter already described had only five contacts, four of which cut out dead resistance coils and the fifth short-circuited a heavy series field winding. It requires very little imagination to picture what would happen if an attempt were made to cut in and out such a combination by means of a swinging arm traveling over contact plates.

In conclusion, it may be well to state that the writer has no interest, pecuniary or otherwise, in the manufacture or sale of motor-controlling appliances; the worse service they give in his immediate vicinity, the more profitable is his occupation likely to be. The most cursory comparison of the actual performance of a sliding-brush apparatus and that of a combination of solenoid switches will readily vindicate the argument here advanced, and the simplified arrangement described is, of course, merely a condensation of solenoid switches.

THE SEPARATION OF MOISTURE FROM STEAM.

BY R. T. STROHM.

The steam which is discharged from the ordinary steam boiler is in most cases initially wet. This is due to the method of formation of the steam. Take, for example, the return tubular boiler. With the application of heat to the water after the boiling point is reached, steam globules are formed along the water surface of the lower plates. These globules, being much lighter than the volume of water which they displace, rise rapidly to the surface of the water. In so doing, they likewise expand slightly, and upon reaching the surface, break through the thin skin on the water surface, and burst. This breaking through and bursting results in throwing a fine mist or spray of hot water upward into the steam space, and the more rapid the boiling, the more violent is this action.

Inasmuch as the water spray thus projected into the steam space is quite finely divided, it is easily held in suspension in the steam and carried along with the current. Consequently, in the case of a boiler which is being forced to its utmost, considerable moisture is thrown into the steam, and is the action which engineers commonly call priming. The percentage of moisture in steam varies greatly, depending upon the details of construction of the boiler, the amount of liberating surface, and the conditions under which the boiler is operated. Ordinarily, however, with normal loading and a fairly well-designed boiler, there is from 2 to 8 per cent of moisture in the steam at the boiler nozzle, while under less favorable conditions the percentage of moisture easily reaches 15 per cent and frequently runs much higher.

Neglecting the moisture which is entrained by the steam before leaving the boiler, the steam entering the cylinder of the engine would still contain more or less moisture, due to the unavoidable loss of heat because of radiation during its passage through the steam pipe. The amount of condensation brought about in this manner depends upon the length of the pipe, the quality of its covering, and the relative temperatures inside and outside the pipe.

As a consequence of the presence of moisture in the steam, it becomes desirable to remove this water for three good reasons: First, the safety of the engine; second, economy; and third, the better lubrication of the engine.

Consider the first reason. Water is practically incompressible. Therefore, if any great amount of it should get into the cylinder and be caught in the clearance space during compression, there would be considerable likelihood of a cracked cylinder, piston or head, or perhaps a buckled rod. It is true that drain cocks properly fitted to the cylinder will remove all ordinary collections of moisture; also, in engines of the Corliss type, the exhaust valves are in such positions as to drain the cylinder quite readily. However, if a boiler primes or foams badly, water may be carried over to the engine in such quantities that the drain cocks cannot possibly discharge it rapidly enough to prevent damage to the engine.

Next, consider the question of economy. It is evident that if the condensation passes through the engine and is thrown out with the exhaust, it loses much of its heat, so that even if it is returned to the boilers, together with the condensed steam, there is a definite loss. On the other hand, if this condensation is removed from the live steam, and immediately returned to the boilers, it will require little more heat to bring it to the temperature of vaporization, since it will have very nearly the temperature of the steam in the main steam pipe. Further than this, the economy of the engine itself will be increased by the use of drier steam, since it is well known that there is less loss by condensation when dry steam is used than when wet steam is used.

Finally, there will be better lubrication in the steam engine cylinder, which will give a higher engine efficiency. For, if there is one thing above all others which will tend to spoil the cylinder lubrication, it is condensation. The hot water washes the oil from the surfaces which would otherwise be well lubricated, and the friction and wear are correspondingly increased. Increasing the rate of oil feeding only partially overcomes the difficulty and makes the oil bill greater.

The point is, therefore, to get rid of this moisture to the greatest possible extent, which may be accomplished either by superheating or by separation. In the present discussion, mechanical methods of separation only will be treated.

All mechanical devices for removing entrained moisture involve one or more of the following principles: First, separation by screens or meshes; second, decrease in velocity of the steam current; third, inertia; fourth, centrifugal force; fifth, baffle plates.

The first method is exemplified by the ordinary perforated dry pipe, by which the water particles are separated from the steam in passing through the holes. This form, however, is adapted only to internal separation; that is, separation occurring within the boiler itself. Consequently, it would remove only such moisture as would be present in the steam before it left the boiler, and would not catch that due to condensation in the steam main.

By decreasing the velocity of flow of a steam current, it is possible to remove a portion of its moisture, especially the larger globules. A current moving at a high velocity is capable of carrying with it water particles of considerable size. If, however, the velocity be suddenly decreased, the force of gravity may so assert itself as to draw out the heavier drops of moisture, even against the entraining influence of the current. In commercial separators this object is accomplished by enlarging the cross-sectional area of the pipe through which the steam must pass on its way to the engine. This is most conveniently done by placing a receiver of considerable volume in the pipe line, this receiver usually containing other devices for removing moisture. The amount of steam leaving the receiver is practically the same as that entering it. Furthermore, the quantity flowing in a given time is always $Q = A V$, in which Q is the cubic feet per minute, A is the area of the passage in square feet and V is the velocity in feet per minute. It is evident from this formula that if the area of the cross-section of the receiver is four times that of the steam pipe, the velocity of the steam in the receiver will be approximately one-fourth that in the pipe. And at this low velocity many of the heavier water particles will fall out of the current to the bottom of the receiver.

Inertia plays no small part in the action of many separators. It is a well-established law that no body can, of itself, set itself into motion, or bring itself to rest, or even change its direction of motion. These effects must be produced by some external force or forces. The application of this principle is of great value in the separation of moisture from steam. If the current of mingled water and steam, flowing along a straight pipe, is suddenly changed in its direction, as by a short bend, or by baffle plates placed directly in its path, a large amount of water may be removed. For the heavy water particles, by reason of their inertia, tend to move in a straight line, while the steam, being lighter, is readily deflected in any desired direction. The result is that the water strikes the walls or baffle plates and clings there, while the steam passes on.

In employing centrifugal force as a means of separating the moisture from the steam, the current is given a whirling or rotary motion. The result is that the water is thrown outward, lodging finally against the containing walls, from which it trickles and is drained off into suitable compartments.

The use of baffle plates of various forms

and varieties of construction is for the purpose of breaking up the steam current into numerous eddies and counter-currents, and also to change the direction of flow as frequently as possible. This enables the inertia of the water particles to be used to the best advantage and at the same time offers a greater area of surface on which the moisture may collect. These baffle plates are usually corrugated.

Fig. 1 illustrates a form of separator which is intended to be placed on a horizontal line of steam piping. The steam enters the separator at *A* and is deflected downward into the annular chamber be-

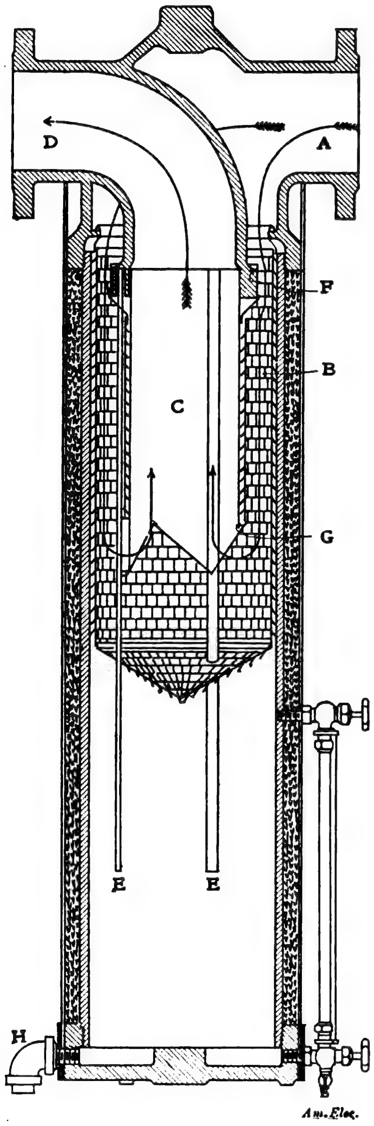


FIG. 1.

tween the central pipe and the perforated cylinder, *B*. The moisture is thus given a rapid downward motion. As it strikes the sides or bottom of the sieve, it goes through the perforations and drips to the bottom of the chamber. The short tongues of metal broken out in making the sieve are bent outward and downward, so that when the moisture has once passed through the sieve it cannot return so as to be caught up again by the steam current. The steam, thus liberated of much of its moisture, passes up the central pipe, *C*, and out at *D*. The pipes *E E* are drain pipes, which carry off the moisture which collects in the projecting lips, *F* and *G*, at the top and bottom, respectively, of the central pipe. It is evident that if this moisture were permitted to run down the sides of the pipe, *C*, and to drop from its lower end, there would be considerable likelihood of its being re-

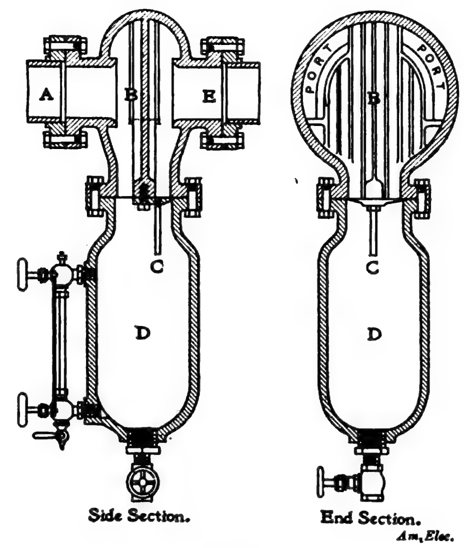


FIG. 2.

absorbed and carried along with the ascending steam current at that point. The water is drawn off through the outlet, *H*, at the bottom of the collecting chamber. The gauge glass is attached so as to enable the engineer to be certain at all times that the separator is fulfilling its duty, and that the water is being properly removed.

In Fig. 2 are shown two views, one a side section and the other an end section, of another well-known make of separator, designed for service on horizontal pipe lines. The steam, entering at *A*, meets a baffle plate, *B*, placed directly in its path. This baffle, as shown in the end section, is contained in an enlarged portion of the separator, and greatly exceeds the area of the steam pipe. On either side of this plate is a port leading to the discharge side of the separator, the sum of these two port

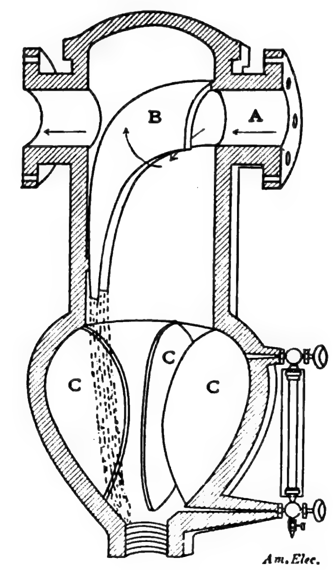


FIG. 3.

areas being likewise greater than that of the steam pipe. It will be seen that this type depends upon change of direction and the baffle plate to secure the desired result. The plate is ribbed vertically, so as to prevent the water from being carried laterally in the current, after having once impinged against the baffle, and also to carry it straight downward into the receiver at the bottom. The advantage claimed for placing the openings at the sides of the baffle plate instead of over it or underneath it, is that this arrangement prevents any possibility of entraining the water with the steam after it has collected on the baffle plate. The drip pipe, *C*, removes all condensation beyond the baffle discharging it into the chamber, *D*. It will be observed that this chamber is totally disconnected from the outlet, *E*, so that the steam cannot possibly pick up water from the settling well, *D*, and carry it out of the separator.

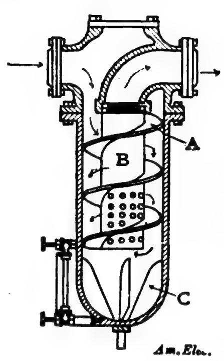


FIG. 4.

The type of separator illustrated by Fig. 3 depends solely upon decrease of velocity and change of direction. The steam current, entering at *A*, is quickly turned downward into the body of the separator by the curved partition, *B*, which serves to precipitate the moisture at the bottom of the reservoir. The vanes, *C*, *C*, *C*, are intended to destroy any rotary motion of the steam current, and also to prevent the water at the bottom of the chamber from being reentrained.

A separator depending largely upon the action of centrifugal force is shown in section in Fig. 4. Here the steam current is given a spiral motion by the vane, *A*, during which the moisture particles are thrown off against the outer wall, from which they trickle to the bottom of the separator. Some of the steam passes through the perforations in the central pipe, *B*, being further relieved of moisture in so doing, while the remainder passes into the bottom of

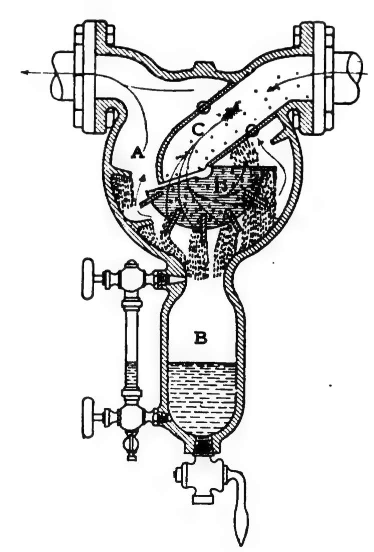


FIG. 5.

the separator, where its whirling motion is largely destroyed by the wings, *C*. It then rises through the pipe, *B*, to the outlet.

A type of steam separator combining all of the four methods of separation previously

mentioned is illustrated in Fig. 5. The device is a cast-iron chamber having practically two compartments, *A* and *B*. The steam is led into the larger chamber, *A*, by the pipe *C*, which is curved at its inner end so as to discharge the steam vertically downward. The inertia of the water then carries it down into the chamber, *B*. The large chamber, *A*, gives the necessary decrease of velocity, which will allow gravity to act upon the moisture, also. Centrifugal force is brought into play by passing the steam current between two curved vanes, one of which is shown at *D*. Finally, a number of baffle plates are placed along the lower edges of these vanes, to catch the moisture thrown out of the current by centrifugal force.

Separators intended for use on vertical lines of steam piping depend upon the same basic principles as the horizontal types already described, and differ only in the details of their construction.

A steam separator should be placed as close as possible to the engine, if the full benefit of separation is to be obtained. If it is placed at some intermediate point on the line, the condensation occurring between the separator and the cylinder will be carried into the engine. If it be placed near the boiler, it will remove only the initial moisture in the steam. Whereas, if placed close to the cylinder, it will take out moisture due either to priming or to later condensation. Ordinarily, the steam pipe to an engine is vertical just above the throttle valve, connecting with the main by a long bend and a horizontal. Manifestly, the nearest point of attachment of a horizontal separator would be in the horizontal pipe leading to the bend, and near the steam header. If a vertical separator is used, it can be placed directly above the throttle valve, in which position it will replace a portion of the pipe, and will act not only as a separator, but as a steam reservoir, as well.

ELECTRIC POWER IN MARBLE QUARRIES.

BY GEORGE E. WALSH.

The marble industry is comparatively young in this country, but in recent years its development in New England and parts of the West has been remarkable. The most extensive marble deposits have been found in Rutland County, Vt., where the resources and quality of the marble are such as to give to this section the name of the Carrara of America. The working of the American marble quarries has been accompanied by the development of tools and machinery for simplifying the work to an extent unknown elsewhere, and while the Italian quarries have been mined for centuries, the methods employed in getting out the marble and cutting and polishing it for the market are crude and primitive compared to those found in operation in the American marble regions.

The latest adaptation of power and machinery to the marble industry is the result of changing conditions. When the quarries were first opened, the range of work was kept within a narrow field, and a single steam plant would often serve to operate derricks, drills and channeling machines. Steam was conducted through pipes to the different machines, and air compressors were driven by the same power to the various places where pneumatic tools were employed. So long as the quarries were of moderate size, the hand and steam derricks, drills and locomotive cranes were sufficient to answer all purposes.

But marble quarrying is rapidly assuming an importance that makes a change of power distribution necessary, and some of the marble quarries have already reached such dimensions that steam power distribution has grown unwieldy and costly and electricity has entered to lessen cost. The smaller quarries may continue indefinitely in their dependence upon steam for operating their drills, cranes, locomotives, channeling machines, polishers and other tools; but the larger quarries are steadily installing electric motors for driving all sorts of labor-saving devices.

Owing to the enormous weight of some of the blocks of marble that are cut and dressed for shipment, such as for obelisks, mausoleums, statuary groups and so on, the derricks and cranes are the most important implements, and modern powerful electric gantry cranes are now installed in most of the larger quarries. One of the most noteworthy of these electric cranes has been in operation for some time at Proctor. Vt. This is a huge, five-motor, electric traveling gantry crane and it displaced ten of the old steam power derricks. It can be operated by one man, and, therefore, saves as much in labor as it does in efficiency. The gantry travels 800 feet, but the distance can be increased indefinitely as the quarry extends. Its maximum capacity is 50 tons, and the blocks of marble can be lifted to a height of 35 feet. This crane was installed chiefly for loading cars; the trains pass directly under the crane, and as the bridge on which the crane travels is 160 feet long it has a wide field of operation.

Smaller three-motor electric traveling cranes on steel railways are also employed. Several ten-ton electric cranes are used for lifting the marble blocks from the quarry and for handling them in the cutting and polishing department. The old powerful boom derricks driven by steam power are still in operation, but their use is gradually diminishing since the advent of the electric cranes, and they are employed now chiefly in isolated parts of the quarry for lifting the blocks from the beds after being cut out.

Portable or locomotive cranes are further making the boom derricks unprofitable; they can travel from one part of the quarry to another, and load blocks directly from the beds to the cars. Both electric drills and channeling machines are now in use in the West Rutland and Proctor quarries, and careful data are being compiled to ascertain the relative cost of the two types. The channeling machines are the most important in a marble quarry, for it is impossible to drill holes in marble and then use high explosives. The blocks must be cut out carefully and lifted without cracking them.

It has only been in the last year or two that electric channeling machines were used at all. But they have given so much satisfaction that their number is being rapidly increased. The new type of electric machine cuts a channel on either side of it from four to ten feet deep and less than two inches wide, whereas the steam type of channeling machine cut but one channel at a time. A single electric motor mounted on the new machine and traveling with it operates the cutting implements and also drives the traction gear of the machine.

Electrically operated chisels, "sand saws," buffers, etc., are also used in the Vermont quarries; in fact, nearly every practical means of reducing hand labor by means of electricity has been adopted. More than $5,000,000 is invested in the quarry machinery and other equipment, a large portion of which is electrical.

THE PERFORMANCE OF DIFFERENT TYPES OF ELECTROMAGNET.

BY CHARLES R. UNDERHILL.

The electromagnet is used in so many

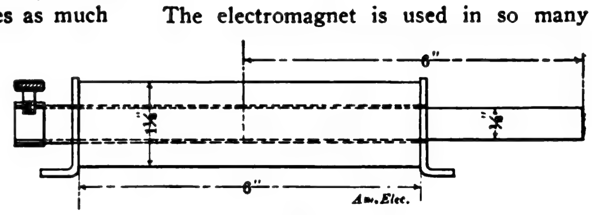


FIG. 1.

different ways, and electromagnetic phenomena taken advantage of to such an extent, that a complete classification of the numerous types would be rather difficult. However, the subject may be treated from a general standpoint, and in this article it is intended to show the general relations between the types in common use. The common types of electromagnet windings were discussed in a former article.*

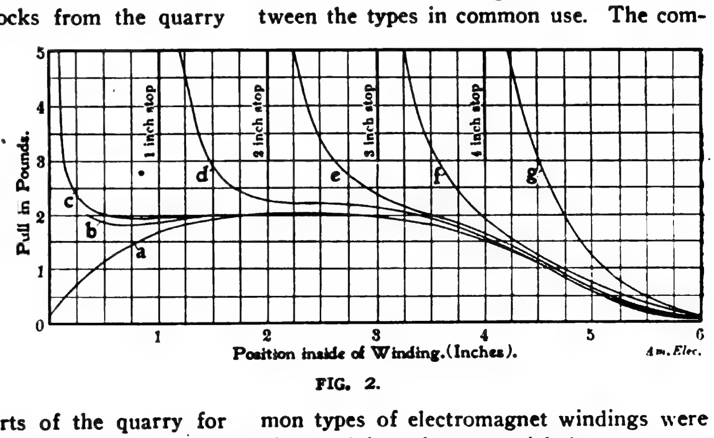


FIG. 2.

If one end of an iron core be placed within the field of a solenoid, it will become a magnet, and mutual attraction will result between the field of the solenoid and the iron core, or plunger, as it is called. Elec-

*AMERICAN ELECTRICIAN, May, 1905.

tromagnets of this type are used where a long range of action is desired. In Fig. 1 is shown a coil-and-plunger arranged for experimental purposes, and Fig. 2 is a chart showing the results of tests made with it. In all cases the ampere-turns were 6300.

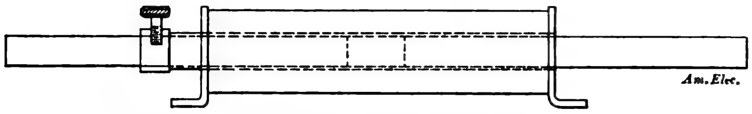


FIG. 3.

Curve *a* is due to the attraction of this coil-and-plunger, the distances being measured from the left end of the plunger to the left end of the winding.

By clamping a rod of iron inside the winding as in Fig. 3, a different effect is obtained. The magnet is now a "stopped" solenoid, or stopped coil-and-plunger.

Curve *b*, in Fig. 2, was obtained from the same coil as before, but with a stop 1 inch long, its right-hand end being flush with the left-hand end of the winding. Curve *c* is from a test with a stop of approximately the same length as the plunger, and with its right-hand end flush with the left-hand end of the winding, as in the case of curve *b*. It is obvious that a small piece of iron at the end of the winding is beneficial, as it prevents the pull from falling off at that end, thereby increasing the effective range of the solenoid. It should be noted that all parts of the frame of this experimental solenoid were of non-magnetic material, the only ferric portions being the plunger and stop.

The curves, *d*, *e*, *f* and *g*, are due to the end of the stop being inserted in the coil 1 inch, 2 inches, 3 inches and 4 inches, respectively. An examination of Fig. 2 shows that curves *c*, *d*, *e*, etc., are the result of the attraction between the plunger and the stop plus the solenoid effect.

A simple solenoid with an iron jacket or frame, commonly called an "iron-clad" solenoid, confines the field within the limits of the frame, thereby raising the curve at the right end, or mouth of the winding, also. Fig. 4 is the result of a test of the iron-clad solenoid in Fig. 5.

An iron-clad stopped solenoid is commonly called a plunger electromagnet; the form shown in Fig. 6 may be considered a plunger electromagnet with a stop practically flush with the left end of the winding.

Fig. 7 shows the difference between the tests of this electromagnet with and without the iron frame. The curve due to the test with the iron frame is marked "iron-clad solenoid," and the test without the frame is designated "simple solenoid." The increased effective range is plainly shown here.

The curves marked "plunger electromagnet" are due to the plunger electromagnets in Figs. 8 and 9. These curves should be compared with curve *f* in Fig. 2. On account of the iron frame, the pulls near the mouth of the coil will be greater than with the simple stopped solenoid.

Tapering the end of the plunger and countersinking the stop have the effect of increasing the pull for long ranges, owing

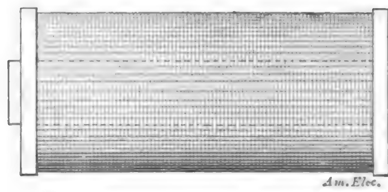


FIG. 14.

to the increased attracting surfaces, but the pull is less as the plunger passes within the stop, owing to the line of attraction being at an angle to the direction of the required pull. An extreme case of the tapered plunger and countersunk stop is shown in Fig. 10 where the taper is nearly as long as the winding.

Fig. 11 shows the result of a test of the plunger electromagnet in Fig. 8 with a stop 2½ inches long. As the test was made, the current in amperes and the pull was noted, and since the number of turns in the winding were known, the ampere-turns were easily calculated, and the curves plotted for each length of air gap. Fig. 12 is plotted from Fig. 11 by taking points vertically on the ordinate for 10,000 ampere-turns, 15,000 ampere-turns, etc., where they intersect the curves representing the different lengths of air gaps.

Returning to the stopped solenoid in Fig. 3, the stop was set at various distances, and the pull then noted for 0.035 inch gaps be-

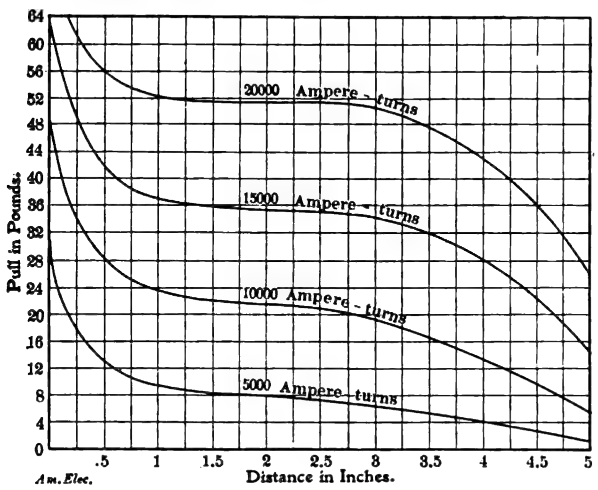


FIG. 4.

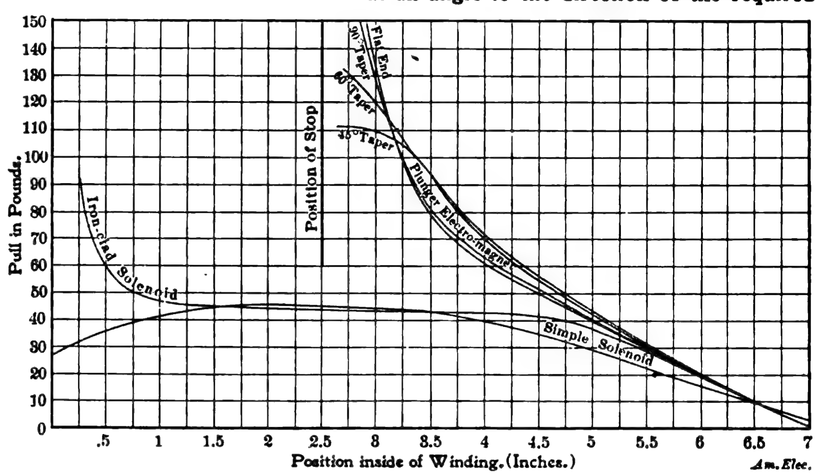


FIG. 7.

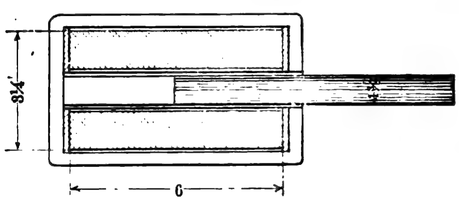


FIG. 5.

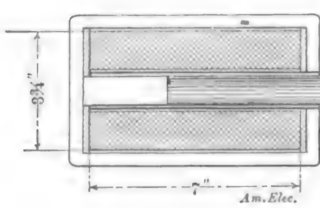


FIG. 6.

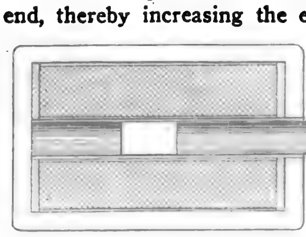


FIG. 8.

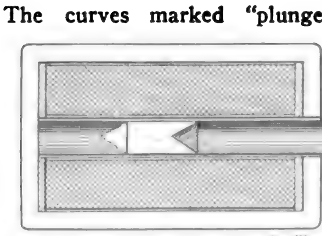


FIG. 9.

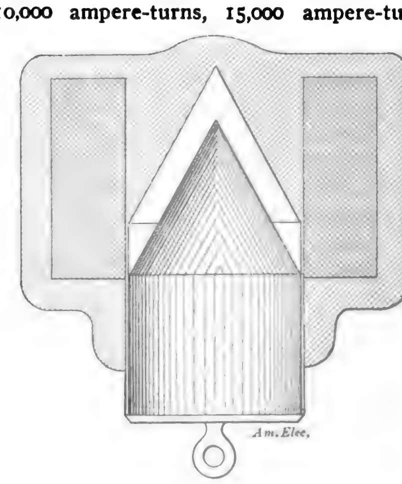


FIG. 10.

tween the plunger and the stop. The curve in Fig. 13 shows the result of this test.

In Fig. 14 is shown a bar electromagnet, which is simply a solenoid with the plunger rigidly fastened within it, so that there can be no motion between them. Therefore, the only function of this type of electromagnet is to attract other magnetic materials to it. If the plunger were clamped firmly inside the solenoid in Fig. 1, this would then be a bar electromagnet.

Now the stopped solenoid in Fig. 3 may be considered as a bar electromagnet with its armature, the plunger, projecting into the winding. It is therefore evident that the bar electromagnet in Fig. 14 is not so efficient as the stopped solenoid (or extreme case for a bar electromagnet), in Fig. 3, as reference to Fig. 13 indicates. Thus, where the working air gap is 1½ inches within the winding, the pull is 25 pounds, while for the same air gap at the mouth o1 the winding, the pull is only 13½ pounds, or about one-half the pull within the winding.

It is also evident that the pull continues to fall off as the proportion of air gap outside of the winding increases. The reason for this is, that the lines leak back on the outside of the winding to the other end of the winding, and therefore do not pass through the working air gap as they would be compelled to do were the gap inside of the winding. This reasoning applies to the horseshoe type of electromagnet, which is a bar electromagnet so bent as to bring its two poles near together; although the strength is comparatively great when the iron armature is in actual contact, or very close to the pole pieces of the magnet, the attraction of the armature by the poles is very weak when the air gap is comparatively small, owing to the leakage back of the armature, from end to end of the cores of the electromagnet. Fig. 15 shows the re-

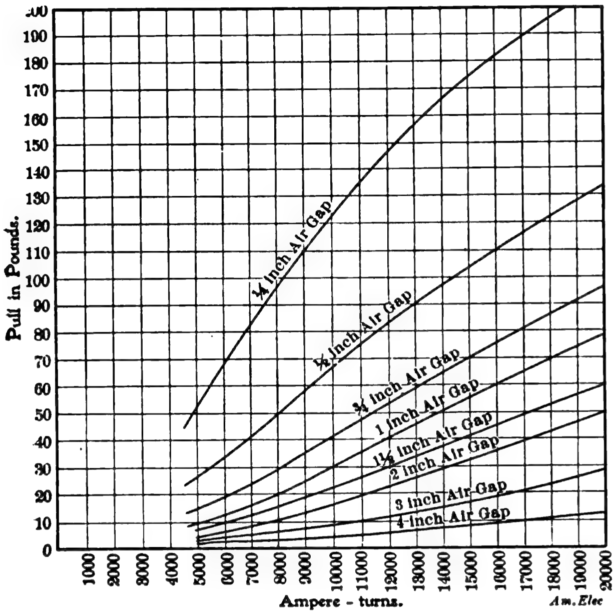


FIG. 11.

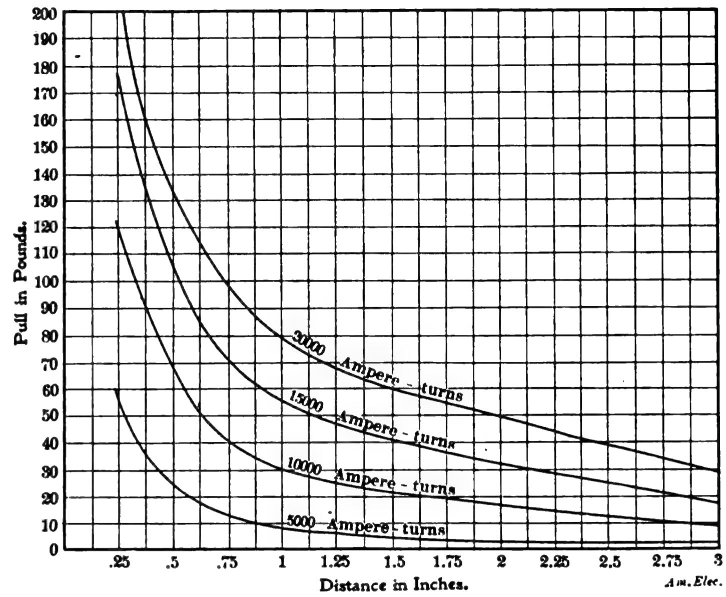


FIG. 12.

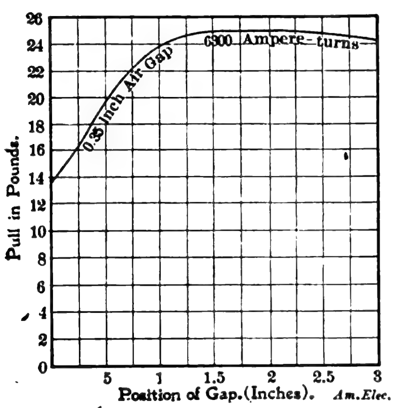


FIG. 13.

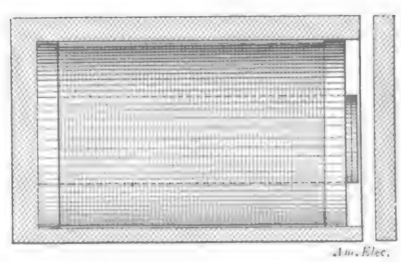


FIG. 18.

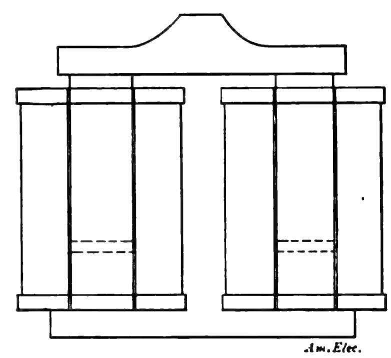


FIG. 19.

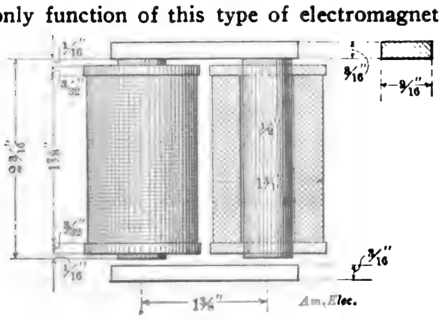


FIG. 16.

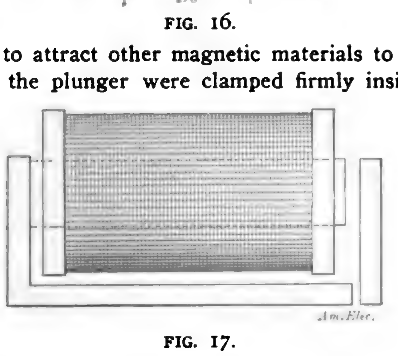


FIG. 17.

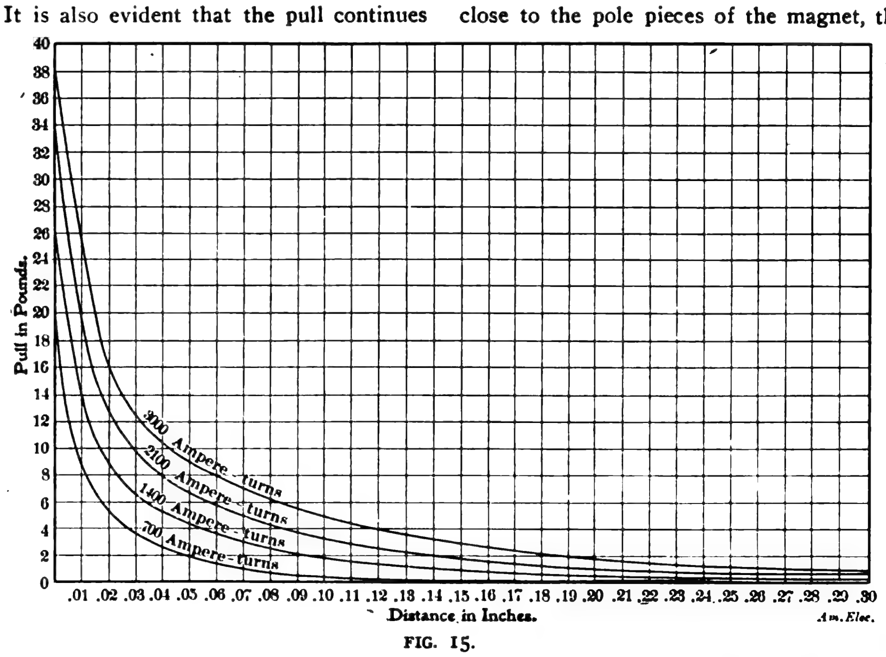


FIG. 15.

sult of a test of the practical horseshoe electromagnet in Fig. 16. The horseshoe electromagnet has many modifications, such as the club-footed electromagnet in Fig. 17, the iron-clad electromagnet in Fig. 18, etc.

From the foregoing it is evident that the bar electromagnet (Fig. 14) or the horseshoe electromagnet are not well adapted for long range work. They are, however, indispensable where rapid action is desired.

It is obvious that the solenoid and plunger electromagnet may have two coils and two plungers as well as one. Fig. 19 shows a two-coil plunger electromagnet, which is really a horseshoe electromagnet with its ordinary armature fastened to the ends of the cores, the cores then being separated at or near the centre of the windings. In this type each core serves as a return circuit for the other core.

Plunger electromagnets and solenoids are adapted for use where a strong pull is required over a considerable range, such as for operating brakes for hoisting motors, electric elevator controllers, railway switches, etc., while electromagnets of the horseshoe type are used for signaling purposes, as in telegraphy and telephony, and also for lifting magnetic bodies in close contact with their pole-pieces.

American Types of Control Apparatus for Direct Current Motors.

BY LAURENCE B. MATHER.

Motor-controlling apparatus may be divided into two general classes, one for merely starting a motor and bringing it up to normal running speed, and the other for starting the machine and also regulating its rate of speed. The former class includes both manually and electromagnetically operated mechanism, while the latter, excepting in very special cases, is restricted to purely manual operation. Simple motor-starting apparatus of the modern manually operated type is always provided with automatic means for restoring the movable member to the "off" or starting position in the event of the failure of the supply current. The apparatus itself comprises a series of resistance coils which are put in series with the armature when the circuit is first closed and then gradually cut out by means of a brush mounted on the free end of a swinging arm and arranged to sweep over a row of stationary contacts connected to the resistance coils. This type is familiar to everyone at all experienced in motor operation. The automatic release consists of a small magnet which is energized as long as the circuit is intact and which holds the starting arm in the full-speed position; cessation of the supply current de-energizes the magnet, of course, releasing the arm, and a spring returns it to the starting position.

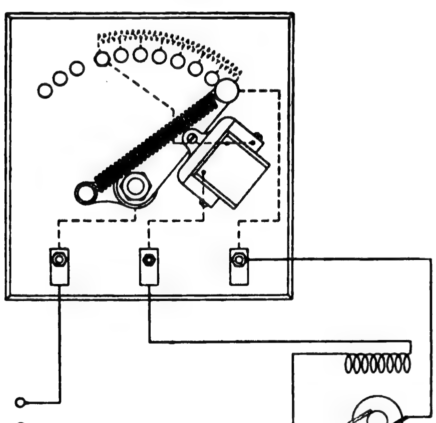


FIG. 1.—FIELD CIRCUIT ALWAYS CLOSED.

Fig. 1 shows a common arrangement of the release magnet and the other parts of the starter. The release magnet is connected in series with the shunt field magnet winding of the motor and the starting resistance when the arm is in the full-speed position, as shown in the diagram; the object of this method of connection is to keep the field circuit always closed. At the first step of the starting arm, the shunt field and release magnet are excited and current is admitted to the armature through the complete starting resistance, and as the resistance is gradually cut out of the armature circuit it is cut into the field circuit;

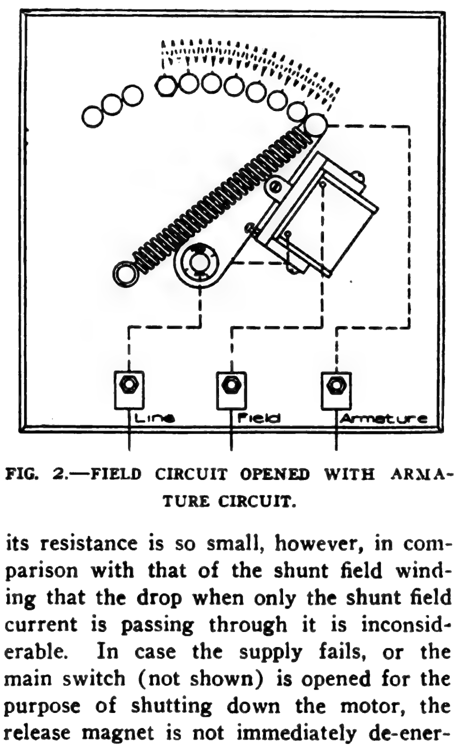


FIG. 2.—FIELD CIRCUIT OPENED WITH ARMATURE CIRCUIT.

its resistance is so small, however, in comparison with that of the shunt field winding that the drop when only the shunt field current is passing through it is inconsiderable. In case the supply fails, or the main switch (not shown) is opened for the purpose of shutting down the motor, the release magnet is not immediately de-energized because the momentum of the armature and sluggish decay of the field magnetism convert the machine into a dynamo of rapidly decreasing e.m.f., and it keeps the release magnet energized for several seconds in some cases; when the armature e.m.f. diminishes sufficiently to reduce the current in the release magnet below the "sticking" point, it lets go and the arm is thrown back to the starting position; but as the release magnet is connected to one terminal of the starting resistance and the free armature brush is connected to the other, there remains a closed circuit through the field winding, armature, starting resistance and release magnet, so that any remaining magnetism in the field magnet has an opportunity to discharge.

The arrangement shown in Fig. 2 was formerly used exclusively, but it has been superseded in many cases by the connection shown in Fig. 1, which is usually preferable because large motor field magnets do not always lose their magnetism sufficiently, before the release magnet lets go, to avoid an objectionable inductive flash when the swinging arm opens the field circuit by leaving the first starting button as it is thrown back to zero by the spring.

Fig. 3 shows still another method of connecting up the release magnet; here, it is connected across the line in series with the starting resistance when the arm is in the running position, as shown in the diagram. This arrangement has the obvious advantage that the magnet is sure to receive full excitation regardless of the character of the shunt field winding of the motor, while in the other cases a shunt field winding of unusually high resistance might take insufficient current to make the release magnet hold the starting arm reliably; in practice, however, this is a rather remote contin-

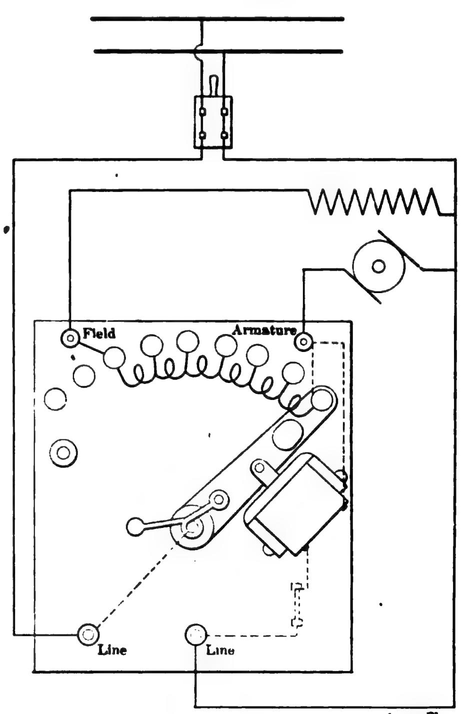


FIG. 3.—FIELD CIRCUIT ALWAYS CLOSED; RELEASE MAGNET ACROSS LINE.

gency, since the release magnet can readily be designed for reliable operation with a current smaller than the field winding can possibly be excited with, and still have radiating surface sufficient to enable it to carry the largest current that any normal

motor field will require. The arrangement of Fig. 3 has the real advantage, however, of being universal so far as the type of the motor field winding is concerned; it can be used with a series, shunt or compound-wound motor without any changes whatever in its own circuits or parts; the diagram shows it applied to a shunt-wound motor, and it is evident that erasing the

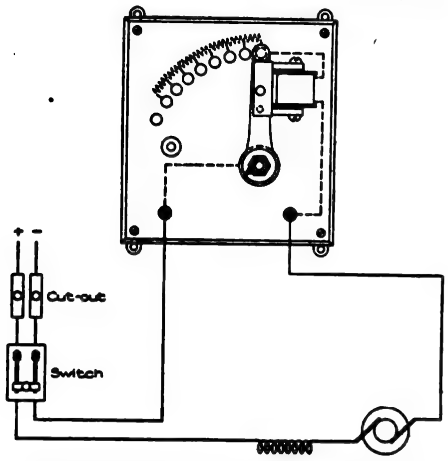


FIG. 4.—USUAL CONNECTIONS FOR SERIES MOTOR.

shunt-field winding and connections from the diagram and inserting a field winding in the armature circuit would make it ap-

FIG. 5.—CUTLER-HAMMER STARTING RHEOSTAT.

ply to a series motor, while inserting the series field without disturbing the shunt-field winding would show it as applied to a compound-wound motor.

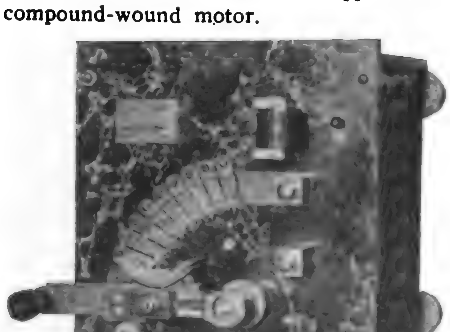


FIG. 6.—CUTLER-HAMMER HEAVY-DUTY STARTER.

For series motors, the common arrangement is as shown in Fig. 4, which requires no explanation. In this case, it is not so important to maintain the field circuit closed after the motor is disconnected from the supply circuit because there are not nearly so many turns in the winding and the inductive e.m.f. due to the discharge of the

FIG. 7.—GENERAL ELECTRIC STARTING BOX.

field magnetism is not high enough to do any damage.

The Cutler - Hammer Manufacturing

FIG. 8.—DOUBLE-CONTACT STARTING BOX.

Company, Milwaukee, for shunt-wound motors uses the method of connection shown by Fig. 1, and its starting box is shown complete by Fig. 5. The starting arm carries near the handle a small bar of iron which comes into alignment with the poles of the single-core release magnet at the right-hand side of the box when the arm reaches the running position. For larger sizes of motor, the starting box is modified slightly to the form shown by Fig. 6. The modification consists in adding a laminated contact brush which, when the arm has been carried around to the running position, bridges two heavy block contacts located beneath the release magnet and thereby short-circuits the starting contacts entirely and eliminates danger of trouble from insufficient contact area in those parts.

In smaller sizes, the General Electric Company uses the starter shown in Fig. 7, which is very similar to that shown in Fig. 5. The chief difference is that a helical spring is employed to restore the starting arm to the "off" position when it is released by the magnet, while in the Cutler-Hammer box the spring is a spiral, coiled about the pivot stud. The method of connecting the release magnet is that shown by Fig. 1. For larger sizes the G. E. starter is made in the form shown by Fig. 8, the internal connections being shown by Fig. 9. The starting resistance is divided into a larger number of steps by the addition of another row of contacts interconnected as indicated. The swinging arm carries an auxiliary finger which is pivoted to the end of the arm and makes a quick snap break when the arm passes the upper button of the right-hand row on being thrown back to "off."

In the largest sizes, the General Electric Company uses the substantial form of starter shown in Fig. 10, in which the traveling brush is of laminated construction like the metal contact bridge of an automatic circuit-breaker, the stationary contacts are trapezoidal plates instead of round

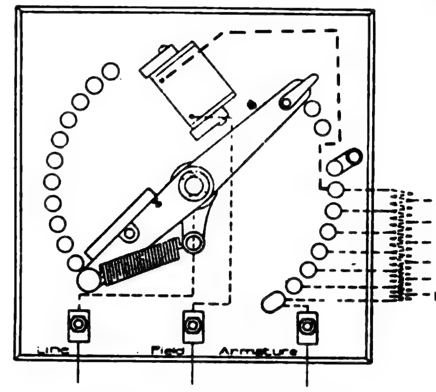


FIG. 9.—DIAGRAM FOR FIG. 8.

buttons, and the release magnet holds the starting arm at "full on" by means of a latch instead of direct magnetic attraction. By reference to the diagram, Fig. 11, and close inspection of Fig. 10, it will be noticed that the swinging arm carries a traveling brush at each end and that only one end of each of these brushes rests on the stationary contacts during the movement of the arm, but when it reaches the running position both ends of both brushes rest on the last contact plates of the two rows, which are extended for that purpose; this gives ample contact surface to carry the full running current without entailing the extra friction that would attend the use of the full contact surface during manipulation of the arm. Fig. 11-A is a detail of the release magnet, its armature and the latch finger on the end of the swinging arm.

FIG. 10.—G. E. HEAVY-DUTY STARTER.

The next step in the simple motor starter line is the addition of an automatic device to open the motor circuit in the event of an overload. The Ward Leonard Electric Company, Bronxville, N. Y., uses an auto-

matic circuit-breaker which operates on exactly the same principle as the apparatus used on switchboards for protecting station apparatus, and interlocks with the starting arm. Fig. 12 illustrates the apparatus. The no-voltage release magnet is shown at the right of the face-plate, as in some of the previous cases, and the circuit-breaker solenoid is located at the lower left-hand part under the auxiliary arm. This arm is pivoted concentrically with the starting arm, and a spiral spring around the pivot

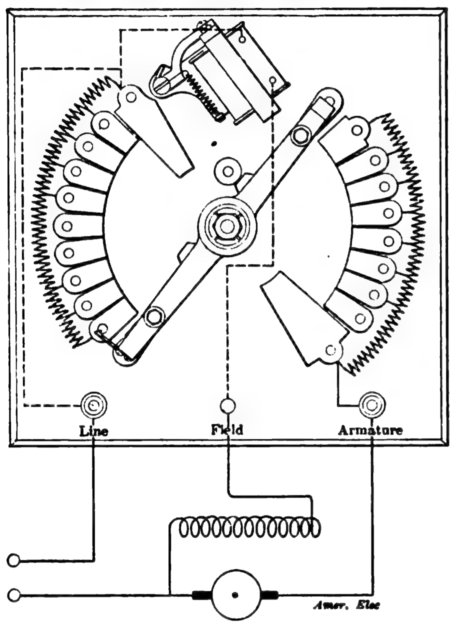


FIG. 11.—DIAGRAM FOR FIG. 10.

post is attached at one end to the starting arm and at the other to the circuit-breaker or auxiliary arm. The right-hand end of the latter carries a brush which bridges two stationary blocks and thereby closes the main motor circuit when the arm is in the normal position shown; in that position it is held at the left-hand end by a latch which is tripped by the solenoid when the load passes the point for which it is set. A lug on the starting arm engages the auxiliary arm when the movement is from right

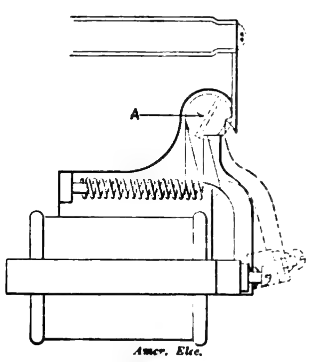


FIG. 11-A.

to left, but when the starting arm is moved around to the running position the circuit-breaker arm is left free to open if it should be released by the solenoid.

When the circuit-breaker lets go with the starting arm in the full running position, the spring throws the auxiliary arm clockwise until it takes up against the lug on the starting arm; this leaves the latter arm still in the full "on" position, but the motor cannot be put in circuit with it in that position except maliciously and by taking the trouble to hold the arm against the release magnet and resetting the circuit-breaker arm with the other hand. There being no handle on the latter arm, there is no normal incentive to do this; the natural

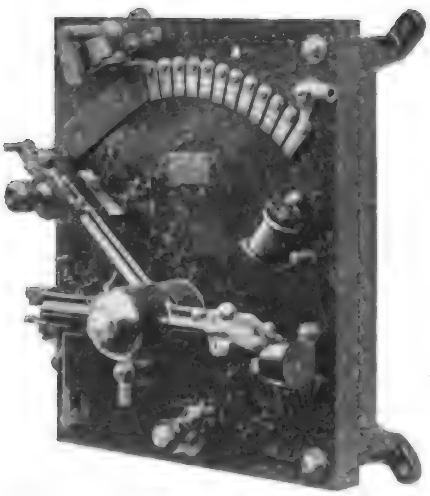


FIG. 12.—WARD-LEONARD STARTER WITH OVERLOAD CIRCUIT-BREAKER.

procedure is to set the circuit-breaker by means of the handle on the starting arm, moving the latter back to its "off" position and thereby restoring the auxiliary arm to its latch. The connections of the starting resistance and release magnet are as shown in Fig. 3; the circuit-breaker solenoid is connected in series with the motor, of course.

As Fig. 12 shows with fair distinctness,

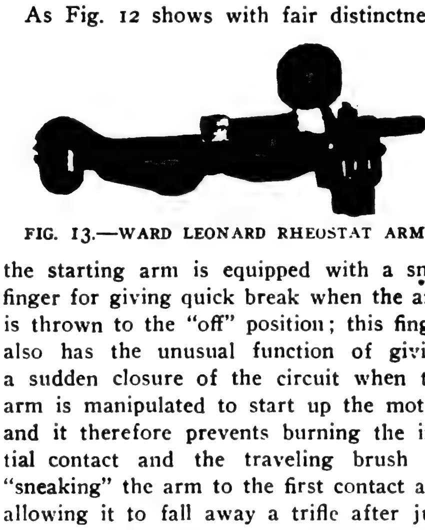


FIG. 13.—WARD LEONARD RHEOSTAT ARM.

the starting arm is equipped with a snap finger for giving quick break when the arm is thrown to the "off" position; this finger also has the unusual function of giving a sudden closure of the circuit when the arm is manipulated to start up the motor, and it therefore prevents burning the initial contact and the traveling brush by "sneaking" the arm to the first contact and allowing it to fall away a trifle after just

FIG. 14.—G. E. STARTER WITH NO-VOLTAGE AND OVERLOAD RELEASE.

touching. The finger is pivoted to the end of the arm and carries a pin which strikes the projecting lug on the post near the first stationary contact when the arm is moved toward that contact and holds the finger out of engagement with its co-operating stationary contact until just before the main brush reaches the first regular contact plate, when it slips past and is thrown by a spring into rubbing contact with a stationary brush. The quick break on the reverse movement is accomplished in a similar manner. Fig. 13 illustrates the construction of the traveling brush on the arm; it consists of several skates on the ends of plungers socketed in the end of the starting arm and pressed downward on the stationary contact plates by individual

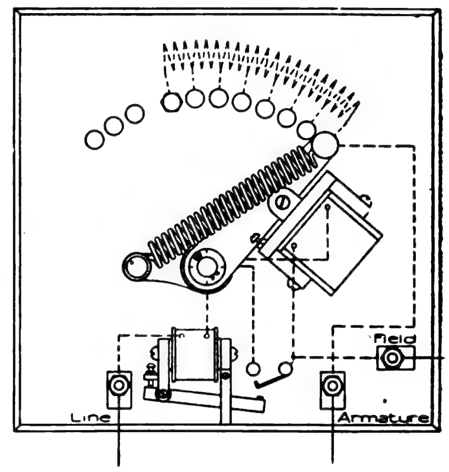


FIG. 15.—DIAGRAM FOR FIG. 14.

springs. The skates are connected to the main part of the arm by means of individual flexible cords so as to obviate the uncertainty and liability to arcing and burning in the sockets which would attend reliance on the contact between the plungers and their housing.

Fig. 14 shows the General Electric type of combined no-voltage and overload release, and Fig. 15 is the corresponding diagram of connections. The overload release consists of an extra magnet in series with the motor and having its armature arranged to short-circuit the no-voltage

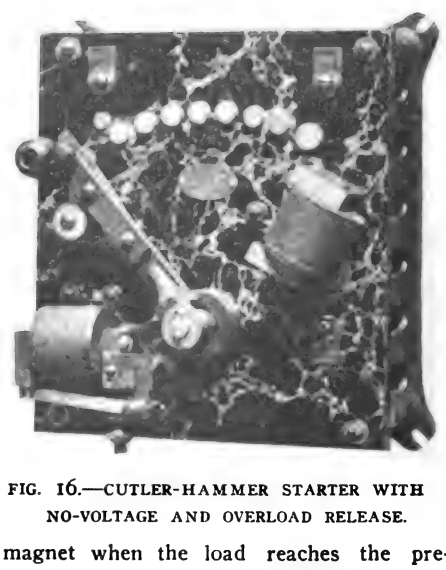


FIG. 16.—CUTLER-HAMMER STARTER WITH NO-VOLTAGE AND OVERLOAD RELEASE.

magnet when the load reaches the predetermined point; in this diagram the no-voltage release magnet is shown connected as in Fig. 2, but the method of connection shown in Fig. 1 is also employed.

Fig. 16 shows the Cutler-Hammer starting box with no-voltage and overload release, the latter feature being arranged as shown in the diagram, Fig. 15. This arrangement is recommended for protection from moderate overloads, but not for

short-circuits or sudden and heavy overloads; it furnishes an excellent means of determining how much current the motor is taking without making an ammeter test, the magnet armature being adjustable to respond to different currents and the short-circuiting connection being rendered inoperative by removing a single screw.

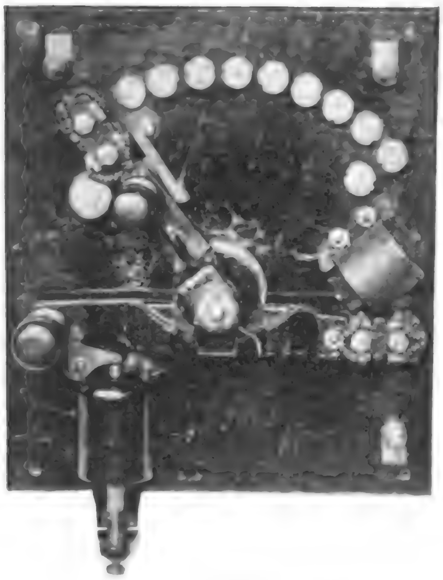


FIG. 17.—CUTLER-HAMMER STARTER WITH OVERLOAD CIRCUIT-BREAKER.

For universal protection against overloads, the circuit-breaker attachment illustrated in Fig. 17 is employed. This mechanism is very much like that already described and illustrated by Fig. 12. When the circuit-breaker lever is released by the solenoid and latch, it is thrown against the starting lever and automatically locked with it so that it cannot be reset without carrying the starting lever back to the "off" position.

The Cutler-Hammer starting box for series-wound motors has the release magnet connected in series with a resistance coil directly across the line instead of in series with the motor, as in Fig. 4.

Fig. 18 illustrates the Cutler-Hammer motor-starter for heavy duty and large motors and Fig. 19 is a diagrammatic view of this type applied to a shunt-wound motor.

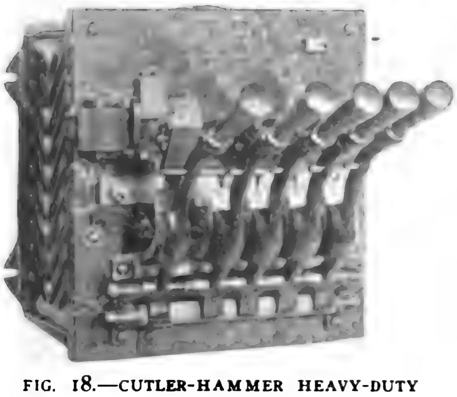


FIG. 18.—CUTLER-HAMMER HEAVY-DUTY SWITCH STARTER.

tor. The starting resistance is divided into a smaller number of sections, the absence of sliding contacts rendering finer division unnecessary. The apparatus consists of a series of switches having laminated butt contacts like those of an automatic circuit-breaker and arranged to short-circuit the sections of the starting resistance. The first switch (on the extreme left) is held in by the release magnet after it has been closed by hand; the others are held closed by latches and are normally prevented from closing by stops, these being arranged so that as each switch is closed it removes the stop from the path of the next switch. The latches are similarly arranged, but in reverse order; thus, in starting, the extreme left-hand switch is closed first, and this closes the motor-armature circuit to the supply line through all of the starting resistance, and closes the field circuit direct; it also removes the stop from the path of the second switch, which is next closed, cutting out a section of the starting resistance; the other switches are closed successively, the last one putting the armature directly across the line, as usual. To shut down the motor, the main switch (shown in the diagram) is opened, cutting off the supply of current to the motor and the release magnet, and the latter releases the first switch. This is equipped with an auxiliary carbon break, and when it opens this takes whatever flash there may

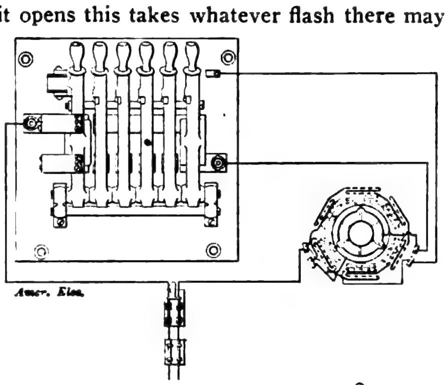


FIG. 19.—DIAGRAM FOR FIG. 18.

be. The opening of the first switch trips the latch of the second one, and that one falls open, tripping the latch of the third one, and so on. The apparatus should never be left with the motor running until all the switches have been closed, and this type is subject to the slight disadvantage that it is possible to leave it in that condition, whereas the older type already described cannot be made to keep the motor in circuit unless the arm is carried all the way to the "full-on" position.

Starting and Regulating Hand Rheostats.

The development of the variable-speed motor regulated by field variation alone or in combination with some armature resistance has led to the perfection of a very convenient form of starting box, including also means for regulating the field strength of the motor. Fig. 20 illustrates the Cutler-Hammer apparatus of this type with both no-voltage and overload release, and Fig. 21 is the corresponding diagram of connections. Two arms are pivoted on the same post, the one nearest the face-plate being the starting lever and the other, having the handle mounted on it, being the speed-regulating lever. The starting lever is moved over to the running position by means of the handle on the speed lever, the latter engaging with the pin in the starting arm near the pivot; when the starting arm reaches the first contact in the armature circuit, it also makes contact with the sector beneath the row of starting contact buttons and thereby short-circuits the field-regulating resistance, giving maximum field; when it reaches the full-speed running position, it

FIG. 20.—CUTLER-HAMMER COMBINED STARTER AND REGULATOR.

leaves the sector and releases the field resistance to the control of the other lever, which may then be moved to any position within its travel. This latter lever connects with the upper row of buttons, which are tapped to the field regulating resistance, and is capable of varying the field strength in the ratio of 2:1 ordinarily, but the rheostat is also built for 3 to 1 and 4 to 1 ranges when so ordered. When the no-voltage release magnet lets go, the starting arm is thrown back to "off" as usual, and carries with it the field-regu-

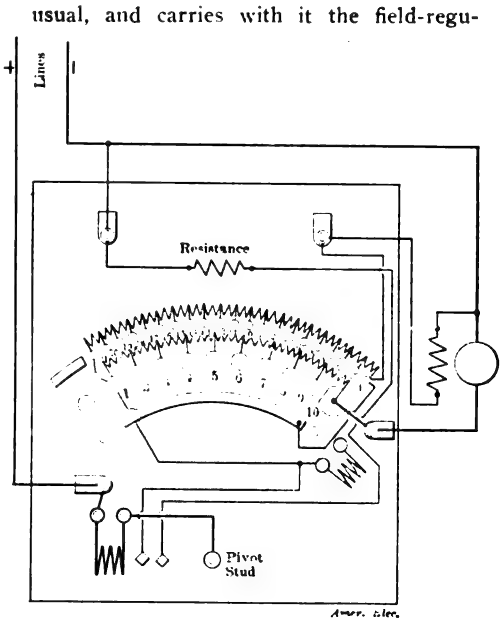


FIG. 21.—DIAGRAM FOR FIG. 20.

lating arm. The release magnet is connected in series with a resistance coil across the line, as shown in the diagram, the variation of field current making it undesirable to put it in the field circuit. The overload release is of the type already described in connection with Fig. 16. This style of starter and regulator is also built

without the overload release, but not without the no-voltage release.

The Ward Leonard combined starter and field regulator is shown in its simplest form by Fig. 22, with no-voltage release and overload circuit-breaker. The starting arrangement, circuit-breaker and release

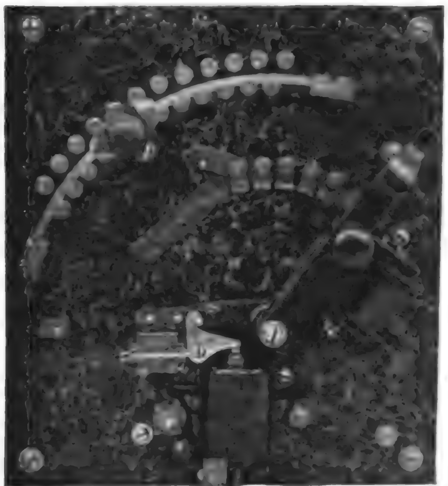


FIG. 22.—WARD LEONARD COMBINED STARTER AND REGULATOR; DOUBLE RELEASE.

magnet are exactly like those described in connection with the Ward Leonard starter. The field strength is regulated by means of the slider and row of contacts shown above the starting contacts, and the starting arm is provided with an extension which carries the speed-regulating slider back to the point of maximum field strength when the arm is thrown to "off" by its spring or by its handle after the opening of the circuit-breaker. This outfit is also built without the overload circuit-breaker.

Fig. 23 shows the Ward Leonard speed regulator for motors driving fans or blowers or in other similar service, where regulation by armature resistance is practical. This device has two arms concentrically pivoted, one of them being held by the no-voltage release magnet while operating con-

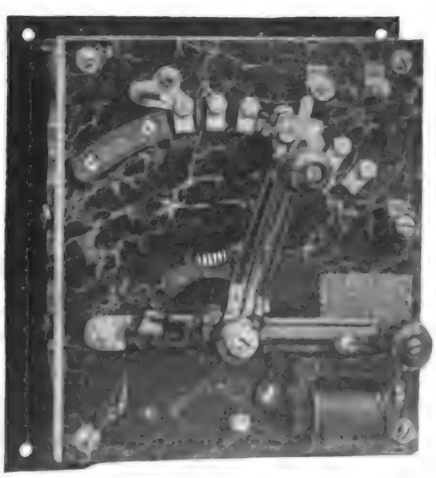


FIG. 23.—WARD LEONARD SPEED REGULATOR; AUTOMATIC RELEASE.

ditions prevail and thrown to the other extreme of its travel by a spring when released by the magnet. The other arm starts and regulates the speed of the motor by varying the resistance in the armature circuit, and it is free to remain in any position in which it may be set. When the spring-controlled arm is released by the magnet, it is drawn over to the left by its spring and carries with it the regulating arm; the latter is equipped with the rapid make and break finger described in connection with the Ward Leonard starting box. This regulator is also built with an interlocking overload circuit-breaker like that used on the ordinary starting boxes of the Ward Leonard Company.

The Ward Leonard controller shown in Fig. 24 combines the functions of the two just described, namely, speed regulation by mean of armature resistance, field variation, and the starting up of the motor from a standstill. It has two operating arms, like the one last described, one of which is held in restraint by the no-voltage release magnet and returned to zero by a spring when released, and the other serves to start and control the speed of the motor. In starting, the right-hand arm is thrown over until the magnet armature rests against the magnet poles, and the other arm is then moved to the first contact plate to start the motor; the first five

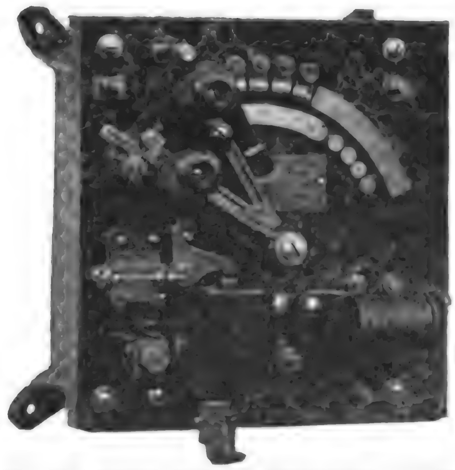


FIG. 24.—WARD LEONARD REGULATOR; AUTOMATIC RELEASE AND CIRCUIT-BREAKER.

contact plates control the speed by resistance in the armature and the last four cut resistance into the shunt-field circuit; the arm remains wherever it is set, of course. To shut down, the main switch (not shown) is opened, and the no-voltage magnet releases the spring-controlled arm, which is thrown back, carrying the speed-regulating arm with it to the "off" position. The engraving shows the apparatus equipped with the overload interlocking circuit-breaker already described, but it is also built without this feature.

Fig. 25 illustrates the Cutler-Hammer compound speed-regulating rheostat. It is of the single-lever type, with no-voltage and overload release and automatic return to the "off" position when released. The swinging arm is held in any position to which it may be adjusted by means of a pawl mounted on the armature of the release magnet and a ratchet mounted on the arm. The first eleven steps vary the resistance in the armature circuit and the last four control that in the field circuit. The no-voltage release magnet is connected in series with the field winding, its duty being so light that the smallest practical field current will operate it; when its armature is attracted, the spring pawl is drawn into mesh with the ratchet teeth in the edge of the disc of the starting and regulating arm, and these teeth are located at the proper points too hold the arm

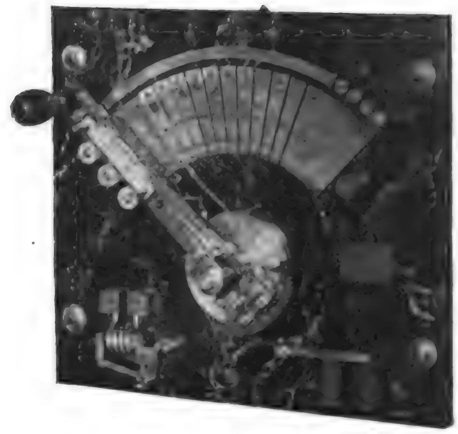


FIG. 25.—CUTLER-HAMMER REGULATOR; BOTH RELEASES.

squarely over one of the contacts, thereby preventing insufficient contact between the stationary plates and the brush. After the armature resistance has been all cut out by the arm, the next step inserts the first section of resistance in the field circuit. When the ratchet is released by the magnet, the arm is thrown to the "off" position by a spring in the usual fashion. The illustration shows the box equipped with an overload release magnet of the short-circuiting type—arranged to short-circuit the other magnet—but the controller is also built without this. It is also built without the field regulating feature, speed regulation being accomplished by varying the resistance in the armature circuit, and all

FIG. 26.—REVERSING STARTER AND REGULATOR; NO-VOLTAGE RELEASE.

other features being the same as in the type described.

The Cutler-Hammer Company also builds an entirely enclosed form of combined starting and speed regulating box,

with and without reversing features and with different automatic combinations. Fig. 26 illustrates the "Carpenter type" compound reversing controller with fifteen forward and three reverse speed and no-voltage release, for printing presses, machine tools, etc.; Fig. 27 is the diagram of connections. The lever cuts in and out resistance in the armature circuit and also inserts more or less resistance in the shunt field circuit in the manner clearly shown by the diagram. It has two arms, solidly connected, one of which controls the armature resistance and one reversing contact and the other controls the field resistance and the other reversing contact. A curved rack on the face-plate co-operates with a roller on the under side of the arm shown in the horizontal position, so as to hold the arm in any running position at which it may be set and prevent the brush being left in a position bridging two of the contact plates and not making adequate contact with either of them. The no-voltage release magnet is provided with a disc-shaped armature mounted on the end of a slider which carries also a copper disc adapted to bridge two stationary contacts and thus complete the armature circuit of the motor. The magnet armature, however, when in its lowest position, is not situated near enough to the magnet poles to enable them to lift it, so that if the supply current should be cut off accidentally while the regulating lever is set at full speed or some intermediate point, and should be restored while the lever is still so set, the magnet will not lift its armature and the motor armature circuit will remain open. Moving the regulating arm to the "off" position causes a pin which it carries to lift the curved lever shown just above the pivot post of the arm; the end of this curved lever is linked to the upper end of the slider, which carries the magnet armature, and when the regulating arm is brought to zero, the magnet armature is lifted near enough to the poles to enable them to lift it all the way when the magnet is energized. The motor may be shut down by swinging the regulating arm to the "off" position, of course; an auxiliary carbon break is provided to take the flash and a magnetic blow-out extinguishes it.

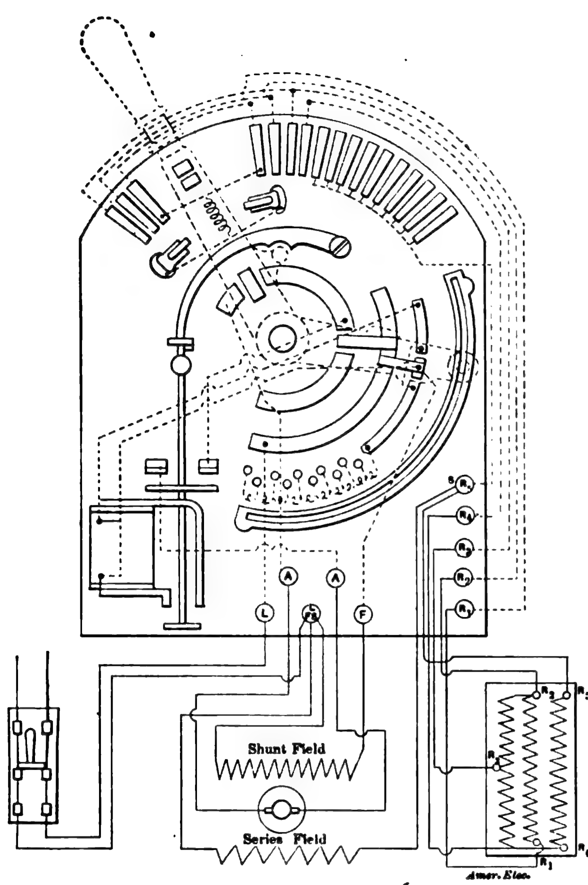


FIG. 27.—DIAGRAM FOR FIG. 26.

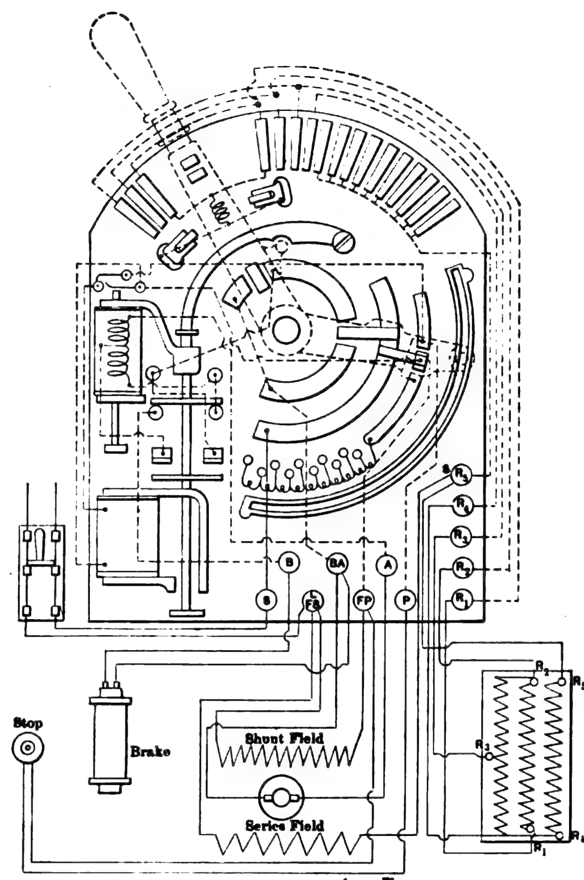


FIG. 29.—DIAGRAM FOR FIG. 28.

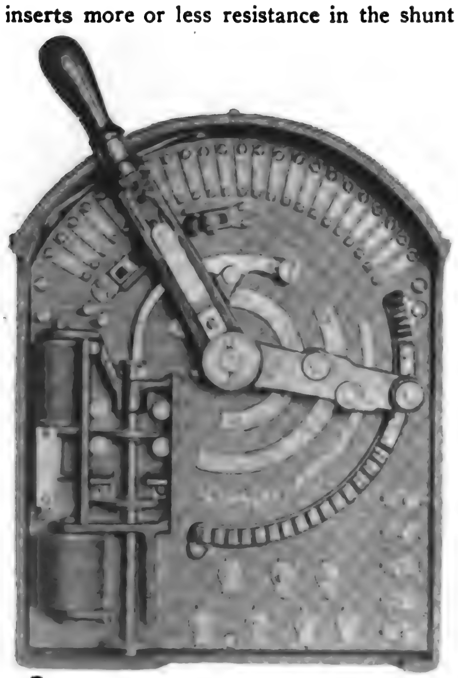


FIG. 28.—REVERSING CONTROLLER WITH BOTH RELEASES.

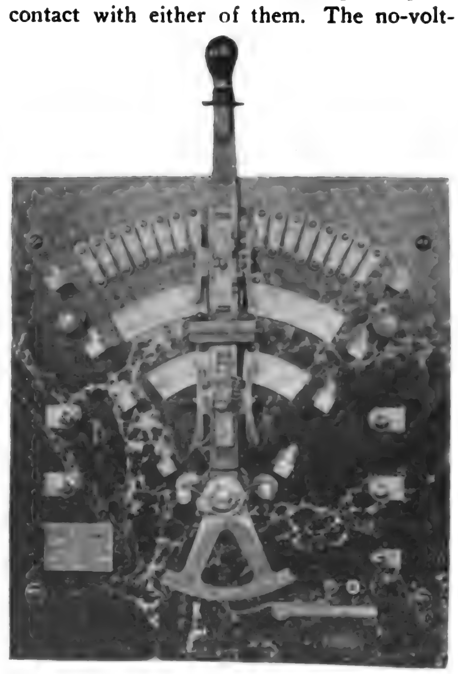


FIG. 30.—CUTLER-HAMMER REVERSING STARTER; NO-VOLTAGE RELEASE.

Fig. 28 shows the same type of controller equipped with overload and push-button release. The overload release consists of a solenoid and plunger arranged to open the circuit of the no-voltage magnet and cause that magnet to drop its armature and open the motor-armature circuit. This break is made on a revolving disc and in a powerful magnetic field which extinguishes the arc instantaneously. This outfit is also provided with a dynamic brake consisting of a resistance which is connected across the armature terminals by an auxiliary pair of contacts located beneath the upper disc on the release-magnet slider so that when the slider drops the brake resistance is connected to the armature. Fig. 29 is a complete diagram of the connections of this controller as applied to a compound-wound motor. The push-button release is merely a circuit-closer of the push-button type connected up to the controller so that closing it energizes the overload solenoid, which is provided with an auxiliary winding for this purpose, and thereby causes the no-voltage magnet to be de-energized and drop its armature.

Full Reversing Hand-Operated Rheostats.

Fig. 30 represents a reversing motor-starter built by the Cutler-Hammer Manu-

facturing Company. Two sets of contact plates are employed and these are cross-connected to avoid duplication of resist-

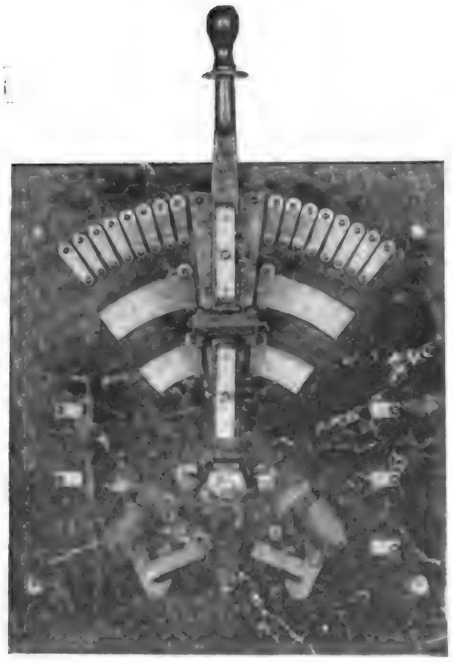


FIG. 31.—CUTLER-HAMMER REVERSING STARTER; NO-VOLTAGE RELEASE.

ance coils; the engraving shows the lever in the "off" position, to which it is returned by one of two springs when not restrained by the no-voltage-release magnet. The magnet holds the lever in either of the full running positions by means of a spring detent attached to the armature and arranged to enter one of two notches in the segment attached to the lever. The rheostat is intended only for starting and bringing the motor to full speed in either

FIG. 32.—CUTLER-HAMMER REVERSING FACE-PLATE CONTROLLER.

direction. The starting lever is divided into two parts which are insulated from each other for the reason that it makes contact with both of the motor brushes in order to reverse the direction of rotation. Each part of the lever carries two laminated copper brushes, one on each edge of it, and when the lever reaches the full

FIG. 34.—WESTINGHOUSE 10-H.P. REVERSING CONTROLLER.

running position in either direction, the two brushes on that side of it short-circuit all of the moving contacts by bridging across stationary contact posts. A similar starting box is shown by Fig. 31, the only important difference being that two restraining magnets are employed and the laminated brushes carried on the edges of the lever in Fig. 30 are not used, the sliding contacts being made of ample area to carry the maximum running current. The

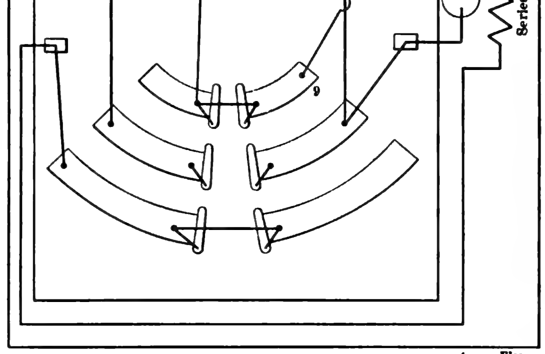


FIG. 33.—DIAGRAM PARTLY APPLYING TO FIG. 32.

restraining magnets hold the arm in the running positions by means of pivoted latches which are automatically set by the short end of the lever as it approaches the "full-on" position. The magnets are connected in series with each other and with the shunt field winding of the motor, directly across the line, so that the field circuit is opened when the lever is drawn to the "off" position, but the magnets have

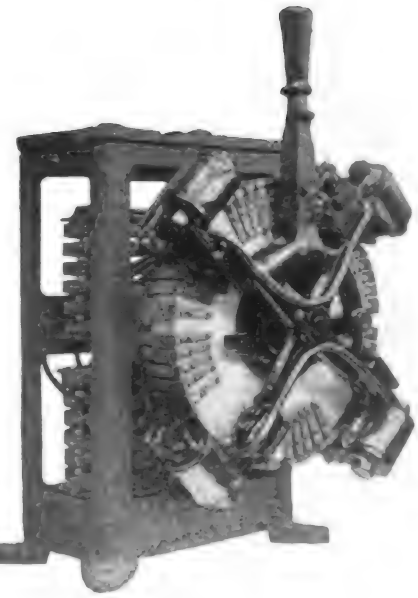


FIG. 35.—WESTINGHOUSE 30-H.P. REVERSING CONTROLLER.

such a powerful "leverage" over the arm that they do not release it until the field magnetism is practically discharged, so that there is no inductive "kick" at the breaking of the connection.

The Cutler-Hammer reversible starter and regulator for crane motors, hoists, etc., is shown by Fig. 32, and Fig. 33 is the diagram of connections for a controller of the same type, but with a single row of contacts. In view of the descriptions thus far

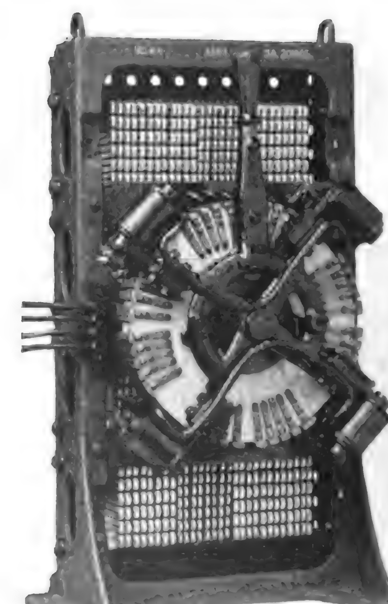


FIG. 36.—WESTINGHOUSE 75-H.P. REVERSING CONTROLLER.

given, these two engravings require no explanation. This rheostat has the unusual feature of a special slow-speed range giving as low as 10 per cent. of the normal full-load speed; the contacts for this slow-

speed range are the three immediately next to the central dead plate on each side, the remaining contacts giving the customary speed ranges up to maximum. Blow-out magnets are provided when necessary for disrupting the arc when the lever is thrown to the "off" position.

Fig. 34 illustrates the reversing and regulating controller of the rheostat type built by the Westinghouse Electric & Manufacturing Company for motors up to 10 horse-power; Fig. 35 shows the form used for motors of 10 to 30 horse-power, and Fig. 36 represents the same class of controller for motors of 40 to 75 horse-power. These controllers are unique in that no separate contacts are employed for reversing the direction of rotation, the arrangement of the brushes and contacts for starting and regulating being such that reversal is accomplished by shifting the spider around to the adjacent row of contacts. For example, lettering the rows of contacts and numbering the four sets of sliding brushes, if brushes *1*, *2*, *3* and *4* have been working on contacts *A*, *B*, *C* and *D* respectively, the motor will be operated in the reverse direction by working brush *1* on contacts *B*, *2* on *C*, *3* on *D* and *4* on *A*. Each brush or set of brushes has its individual blow-out magnet, and the circuit is broken at all four sets of brushes when the lever is thrown to the "off" position. As the illustrations show, the smallest size of rheostat is of the face-plate type, while the others are of an unusual construction, the stationary contacts being mounted around the periphery of a soapstone disc instead of on the face of it.

Resistance Conductors.

In the smaller capacities of motor-starting and speed-regulating rheostats the Cutler-Hammer Company uses helical coils of resistance wire wound on asbestos tubes, as indicated in Fig. 38. The joints are all soldered and so located that they are kept cool even when the resistance coil is very hot. The ends of the asbestos tubes are made moisture proof, and the iron frame in which they are mounted is heavily enameled; it is claimed that the insulation resistance between the conductors and the frame is over a megohm. For larger sizes,

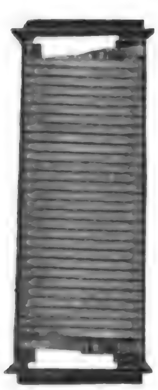


FIG. 37.

FIG. 38.

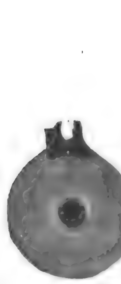


FIG. 39.

the conductor is a thin ribbon wound on an insulated iron frame, as shown by Fig. 37; the material and the insulating precautions are the same as in the smaller type. The next higher capacity is a thicker ribbon wound into a disc, as shown by Fig. 39, with an asbestos strip between the successive convolutions. Grids are also used in the very heavy capacity rheostats.

The insulation of the resistance conductor in the controllers illustrated by Figs. 26

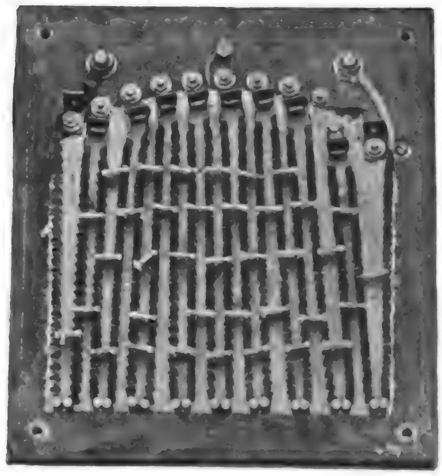


FIG. 40.—WARD-LEONARD RESISTANCE.

to 29 is accomplished in a highly novel manner. A pane of glass, the full size of the resistance case, is laid in the case, and on this are laid strips of glass on which are wound the conductor; on top of these is laid another pane of glass the full interior size of the case. The whole is then heated in an oven to a temperature just sufficient to soften the glass thoroughly, and it is then removed and the mass compressed while the glass is in the softened state; the result is a non-absorptive insulating structure in which the resistance conductor is thoroughly embedded.

The resistance conductor used by the Ward Leonard Company is a special alloy made up in either helical coils of wire or corrugated strips

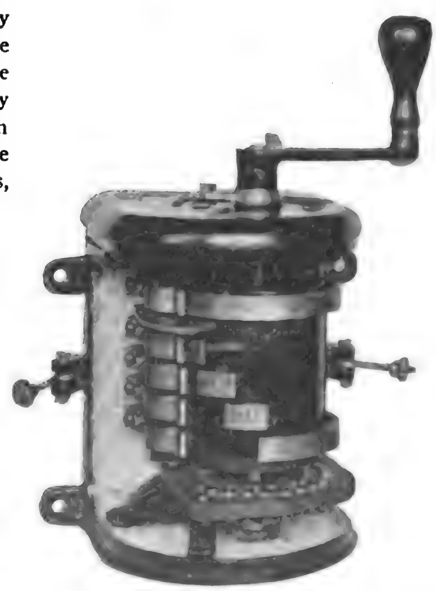


FIG. 41.—CUTLER-HAMMER DRUM CONTROLLER.

of thin ribbon, according to the current to be carried. The conductor is attached to the back of the slate face-plate, as indicated in Fig. 40, several sheets of asbestos being interposed between the conductors and the slate to prevent heating the latter. A hollow iron casing, closed on all sides except the one next to the slate, is then fastened to the slate, a tight joint between the two being made with putty; pure sand is then poured into the casing through a small hole in the wall which is afterwards closed with a plug. The sand completely fills all spaces between the casing and the slate not occupied by the conductor and its fastenings. The claims made for this sand filling are as follows: (1) It has a low temperature coefficient, or more properly, a high specific heat capacity, so that it will absorb and transmit to the iron casing a great deal of heat without an objectionable rise in temperature; (2) it is highly insulating and fire-proof; (3) it does not absorb moisture; (4) it flows freely and makes perfect contact with the surface of the metal ribbon even if the ribbon moves slightly, due to expansion and contraction, or due to vibration; (5) it is a good conductor of heat, hence the heat developed in the ribbon is rapidly and evenly taken up by the mass of sand; (6) it can be readily removed, so that the cast-iron box can be taken off for the purpose of inspection or repair of the resistance, and the same sand can be readily put back again in the box afterward; (7) it fills the entire space and holds the ribbon so that it is not subjected to any mechanical strain; (8) in case the resistance be fused by excessive current, the arc is instantly and quickly extinguished, just as in the case of an enclosed fuse.

Drum-Type Controllers.

For machine-tool motors, the drum type of controller has come more into favor because of its rugged structure, compactness

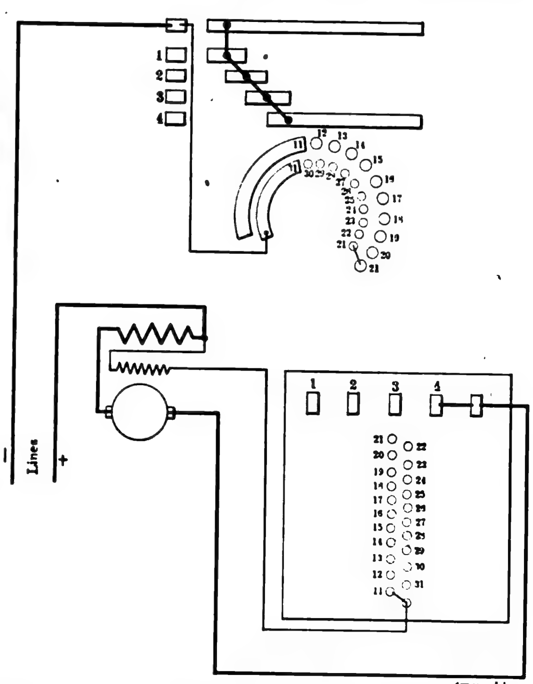


FIG. 42.—DIAGRAM FOR FIG. 41.

and complete enclosure. Fig. 41 represents the Cutler-Hammer drum controller for this class of service, designed for motors to be regulated by field vibration. The starting resistance is cut out of circuit by means of

spring fingers and cross-connecting curved contact plates on the drum, while the field resistance is inserted, little by little by means of a finger attached to the drum immediately below the drum and arranged to travel over a double row of stationary contacts. The general lay-out is clearly indicated in the engraving, and Fig. 42 shows the connections plainly. The resistance coils are

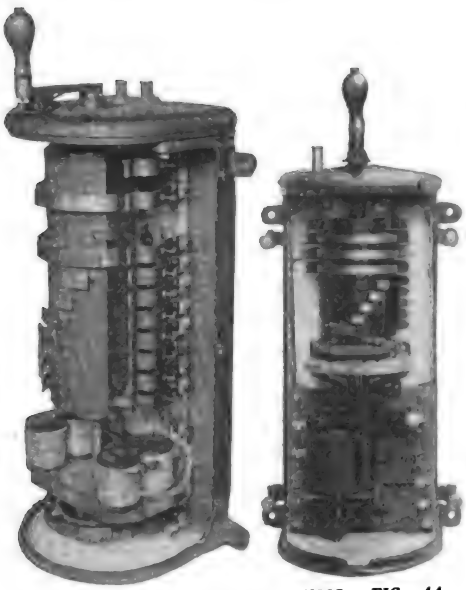


FIG. 43.—CUTLER-HAMMER DRUMS.—FIG. 44.

mounted in a separate frame and connected to the two divisions of the controller as indicated by the numbers on the terminal posts in Fig. 42. Magnetic blow-outs are provided wherever necessary. The controller here shown is non-reversing, but the same type is made in the reversing form, in which the handle is swung in one direction for forward rotation and the other direction for reversing; the lever is prevented from going past the zero point, when thrown back to it, by means of a latch which may be released by the push-button in the center of the controller handle when it is desired to reverse.

Fig. 43 illustrates the Cutler-Hammer

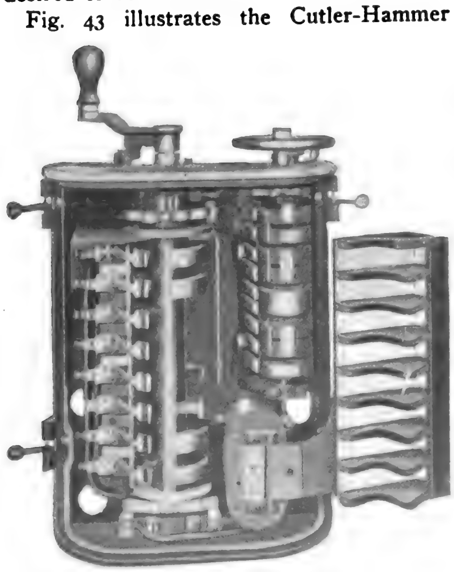


FIG. 45.—GENERAL ELECTRIC RHEOSTATIC CONTROLLER.

drum controller for cranes or other classes of service where speed regulation by variable resistance in the armature circuit is employed. This is a reversing apparatus, and the resistance coils are, of course, contained in a separate frame and connected to the controller by the usual multiple-conductor cable. The main circuit is initially closed and finally broken by contacts in the bottom compartment of the case, and blow-out magnets are mounted directly above this compartment; the contacts on the main part of the drum are for speed regulation only.

When no-voltage and overload release are

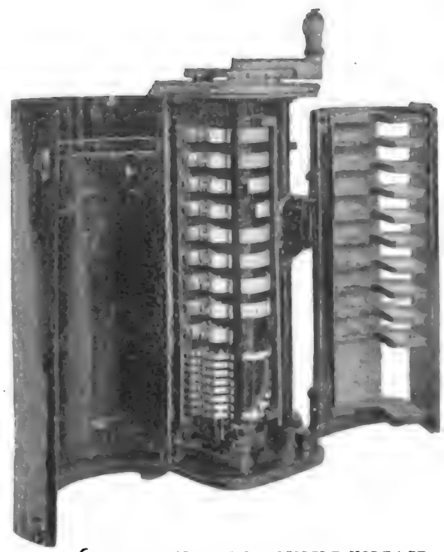


FIG. 46.—WESTINGHOUSE SINGLE-VOLTAGE CONTROLLER.

desired, the Cutler-Hammer drum-type controllers are fitted up as shown by Fig. 44, the magnets being located beneath the drum part of the controller. The no-voltage release device is a solenoid switch, the winding of which is either across the line in series with a small resistance coil or in series with the shunt field winding of the motor, and the switch contacts are in the main motor circuit. The overload release is a small magnet in the motor armature circuit, its armature being arranged to cut out the release magnet when maximum load is exceeded, as previously described in connection with the face-plate types of motor starter.

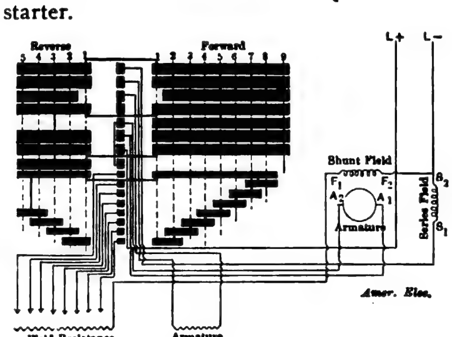


FIG. 47.—SMALL-MOTOR CONNECTIONS.

The General Electric Company makes a very complete line of drum controllers for power and mining-service motors which are of exactly the same general type as the company's well-known street railway apparatus. Fig. 45 illustrates a reversing controller of this class, for rheostatic control; the reversal of the motor is accomplished by means of a separate drum, as in the usual street-car controller, and a powerful blow-out magnet is provided to disrupt the arc when the controller is thrown to the "off" position under a load. The "K type" drum controller is also built for mining motors, cranes and similar heavy duty, where more than one motor is employed and the machines are series-wound; this being a series-parallel controller exclusively.

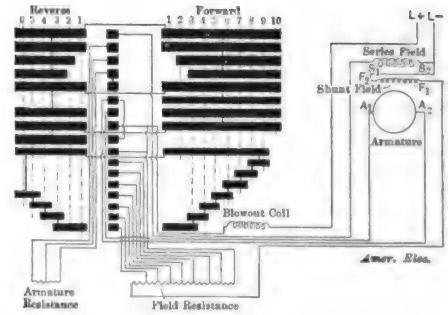


FIG. 48.—LARGE-MOTOR CONNECTIONS.

The Westinghouse Electric & Manufacturing Company builds drum-type controllers for both single voltage and double voltage, the latter being used in connection

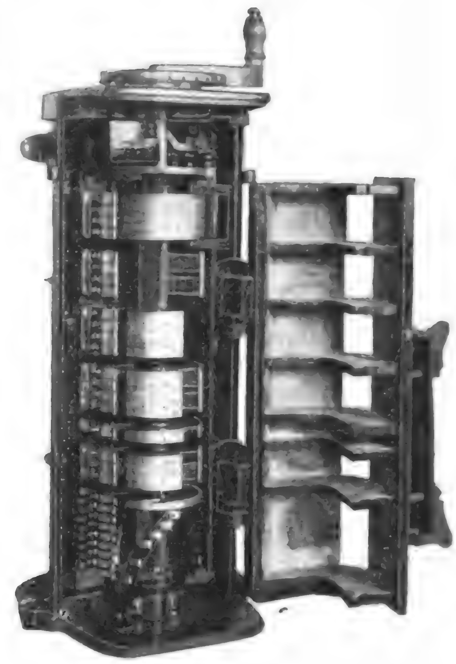


FIG. 49.—WESTINGHOUSE DOUBLE-VOLTAGE CONTROLLER.

with the Westinghouse three-wire system or any other giving the same two fundamental voltages. Fig. 46 illustrates the single-voltage controller; in medium and larger capacities, this type has two starting notches and gives eight forward running speeds and four reverse speeds. Speed control is effected entirely by varying resistance in the shunt field circuit, resistance coils being

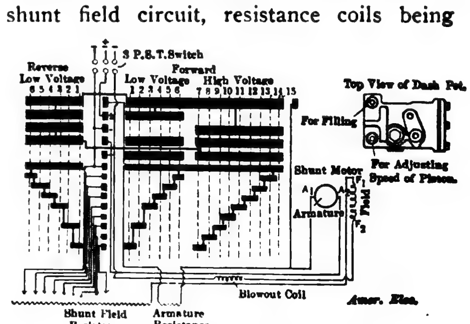


FIG. 50.—DIAGRAM FOR FIG. 49.

used in the armature circuit for starting only. The resistance coils are all mounted in a separate frame and connected to the controller and the motor by cables. Fig. 47 is the diagram of connections for the 10-h.p.

size and Fig. 48 is that for larger sizes, the controller strips being shown "developed." The double-voltage controller is represented

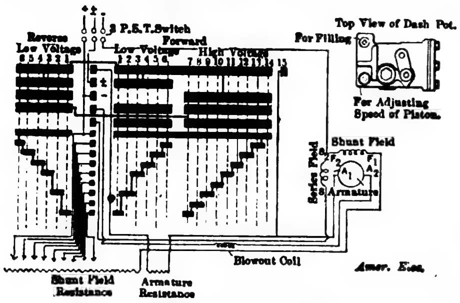


FIG. 51.—DIAGRAM FOR FIG. 49.

by Fig. 49; Fig. 50 is the corresponding diagram of connections for this controller used with a shunt-wound motor, and Fig. 51 the diagram for use with a compound-wound machine. The controller gives fifteen forward speeds and six reverse speeds, six of the forward speeds and all of the reverse speeds being obtained on the lower voltage and the remaining nine forward speeds at the higher voltage. The starting resistance is automatically cut out by a spring-actuated contact which is released by the controller and retarded by a dash-pot. In both the single-voltage and double-voltage controllers the notched disc which locates the controller "points" is so arranged that it is difficult for the operator to sweep the handle past a notch without a pause.

Remote Control Apparatus.

The industrial field in which remote control of direct-current motors is chiefly practised is that of electrically-driven elevators; there are, of course, several special cases such as turret motors on warships, derricks and hoists in peculiar situations, high-speed electric railways such as the Manhattan elevated and subway systems, etc. Space limitations preclude a discussion, even of the briefest kind, of all such special apparatus and systems.

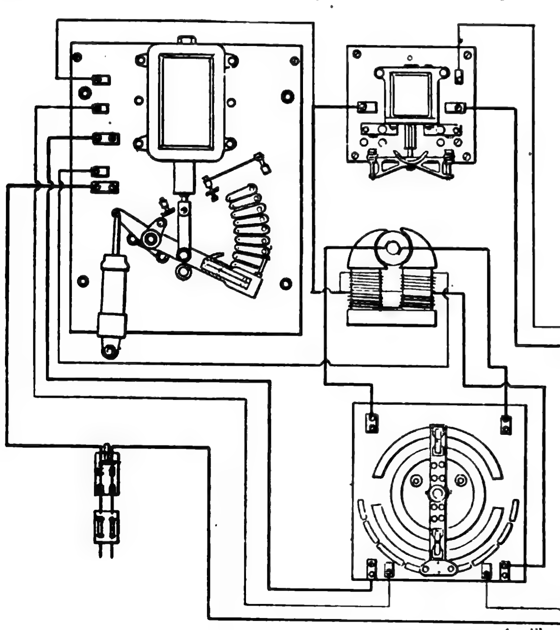


FIG. 52.—ELEVATOR SYSTEM WITH MECHANICAL PRIMARY CONTROL.

In the electric elevator field, the connection between the apparatus manipulated by the attendant and that which directly controls the motor may be either mechanical or electrical; the latter is becoming more and more preferred over the former, which is employed now almost exclusively for freight service and unimportant passenger installations. Even when mechanical primary control is employed, the mechanism which effects the acceleration of the motor from standstill to full speed is purely automatic after it has been

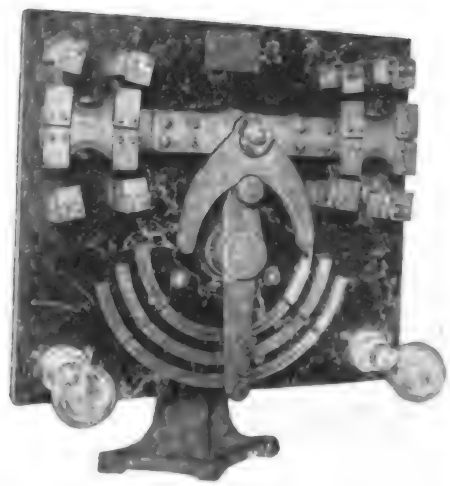


FIG. 53.—MECHANICALLY-OPERATED REVERSING SWITCH.

released by the operator. As a general rule such a system comprises a main reversing switch operated mechanically by means of either a hand-rope or a wheel and small cables from the car, a switch for cutting out the starting resistance and arranged to be put into operation by the closure of the reversing switch in either direction, and either a simple mechanical connection between the brake-band or shoes and the reversing switch or a solenoid put in circuit by the closing of the reversing switch and arranged to release the brake.

Fig. 52 is a diagram of one of the Cutler-Hammer elevator systems with mechanical primary control from the car. It consists of a reversing switch, which is shown in Fig. 53, a main circuit-closing solenoid switch, shown by Fig. 54, and another solenoid switch, Fig. 55, which cuts out the resistance in the armature circuit. Referring to Fig. 53, the horizontal arm makes the connections to the brushes of the motor which determine its direction of rotation and the vertical arm closes the circuit of the main solenoid switch and then that of the accelerating switch. The vertical arm is mounted on a spindle which carries on its other end a sheave to which the cable running to the elevator car is attached. When the operator pulls the switch arm to zero it breaks the exciting circuits of the main-switch solenoid and accelerating solenoid and then throws the reversing-switch arm to the mid position; it also connects to the shunt field terminals the two incandescent lamps on the panel so that the field magnet may discharge without an objectionable "kick." The diagram shows a circular type of reversing switch which is used for small capacities, but the reader will easily understand the substitution of the knife-blade switch shown by Fig. 53. The automatic accelerating switch (Fig. 55) is provided with a small auxiliary contact finger which short-circuits an incandescent lamp connected in series with the solenoid winding; when the lever is drawn up to the position of full speed it lifts this finger and puts the lamp actively in circuit with the winding and prevents overheating. The main solenoid switch is equipped with auxiliary carbon-faced contacts which take the arc when the circuit is opened; it also has powerful blow-out magnets mounted on the back of the panel with their poles projecting through holes on each side of the vertical plane of each pair of carbon contacts.

The highest development in the way of electric elevator controlling apparatus comprises solenoid-actuated switches for making all contacts, a simple two-way switch in the elevator car serving to put the apparatus into or out of operation. Fig. 56 illustrates an outfit of this type built for four sections of starting resistance in the armature circuit and having a special equipment of pressure regulators. The two switches at the bottom of the panel close the main circuit to the motor, the one for operation in one direction and the other for running in the contrary direction. The solenoid windings of these two are connected to the supply cir-

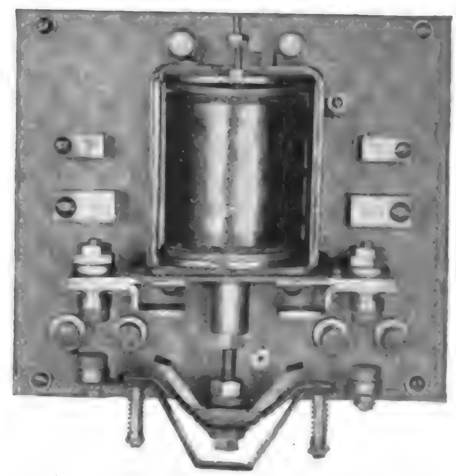


FIG. 54.—CUTLER-HAMMER SOLENOID SWITCH.

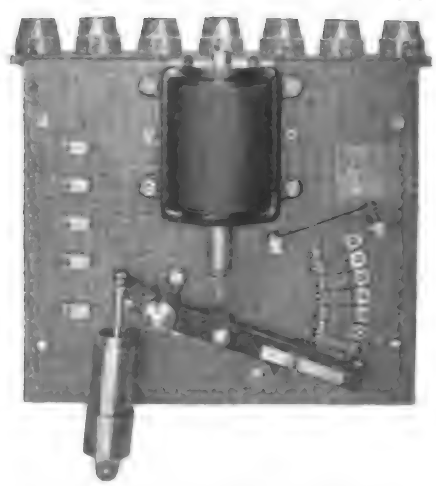


FIG. 55.—CUTLER-HAMMER ACCELERATOR.

cuit by the hand switch in the car. When either of them closes the motor circuit it also closes the circuit of the upper left-hand solenoid, and this draws up its plunger gradually, the motion being retarded by the dash-pot; as the brush on the free end travels over the row of stationary contacts, it closes the circuits of the four small solenoids successively, and these cut out the sections of the starting resistance in the armature circuit. Each of the switches is equipped with carbon contacts which take the flash at the breaking of the circuit. This type of controller is also built for non-reversing motors, in which case one of the main solenoid switches is omitted, of course.

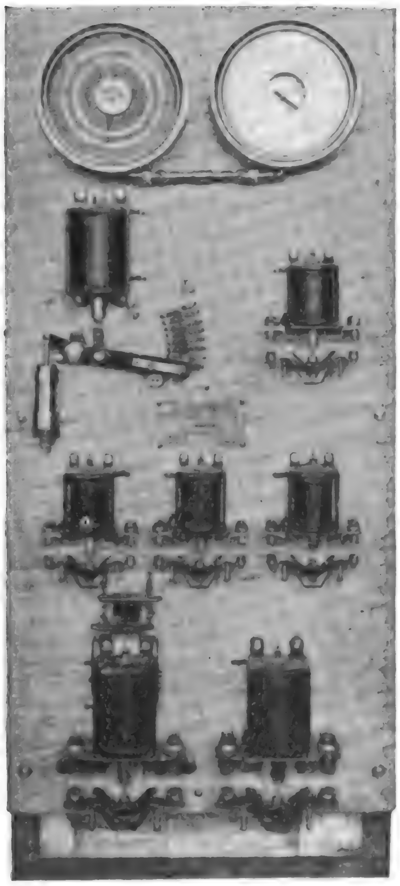


FIG. 56.—CUTLER-HAMMER ELEVATOR CONTROL PANEL.

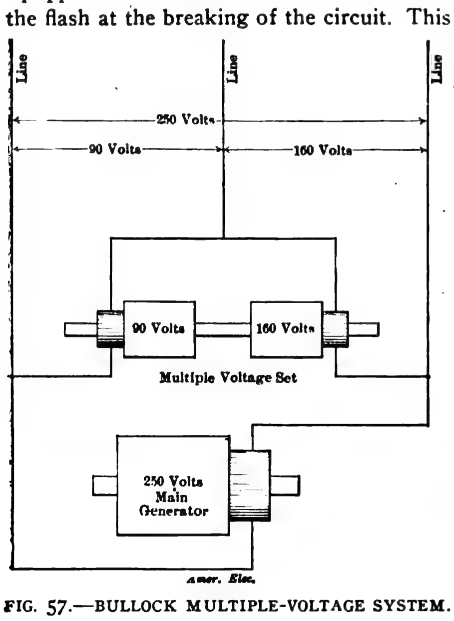


FIG. 57.—BULLOCK MULTIPLE-VOLTAGE SYSTEM.

Special Control Systems.

Besides the apparatus built for controlling motors supplied from simple supply circuits, there have been developed complete systems of speed control of which the fundamental feature is either the variation of the applied e.m.f. at the armature terminals by means other than dead resistance or variable grouping of two armature windings combined with variable field strength. One of the earliest of the multiple-voltage systems to be exploited for industrial purposes was that of the Bullock Electric Manufacturing Company. In this system, a 250-volt generator is employed to give the maximum voltage and supply the energy to the distribution mains and a motor-balancer is used to furnish the lower voltages; this arrangement is indicated diagrammatically by Fig. 57, where the motor-balancer is designated "Multiple voltage set." This set operates on the same principle as the ordinary pair of coupled motors on a three-wire system in which the voltage is the same on both sides of the neutral conductor. As the diagram indicates, the lowest fundamental voltage is 90 volts, and the e.m.f. on the other side of the middle wire is 160 volts. The controller, of which Fig. 58 is a view with the cover removed and Fig. 59 a diagram of connections, starts the motor on the 90-volt wires and varies the resistance in the field circuit to give three speeds at this voltage; it then shifts the armature to the 160-volt wires and repeats the variation of field excitation; the next "notch" puts the armature on the outer wires, at 250 volts, and there are six forward and three reverse speeds at this voltage, making twelve forward and nine reverse speeds in all. The armature resistance is inserted each time the motor is shifted to a pair of wires of higher voltage, and is immediately cut out by a solenoid which is put in and out of circuit by the controller drum. The motor field winding is excited from the outer wires in all positions of the controller. The reverse speeds, as the diagram indicates, are obtained by swinging the controller handle in the opposite direction from that which gives forward rotation. Fig. 60 shows the motor-balancer, which requires no further description.

The Bullock Company also builds a four-wire, six-voltage system which gives twenty-six forward and six reverse speeds, a three-motor balancer being employed to sub-divide the main voltage. Fig. 61 is a diagram of the voltage distribution; the voltages are 60, 80, 110, 140 (between wires *A* and *C*), 190 (between wires *B* and *D*) and 250. These, of course, give six speeds, and the

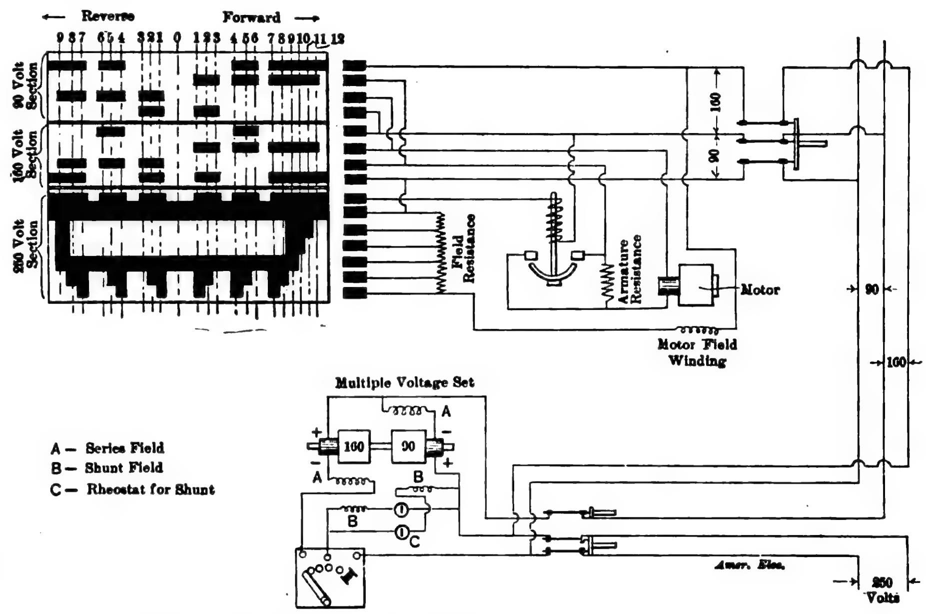


FIG. 59.—DIAGRAM OF CIRCUITS, BULLOCK MULTIPLE-VOLTAGE SYSTEM.

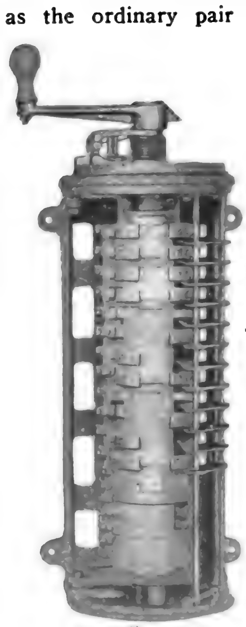


FIG. 58.

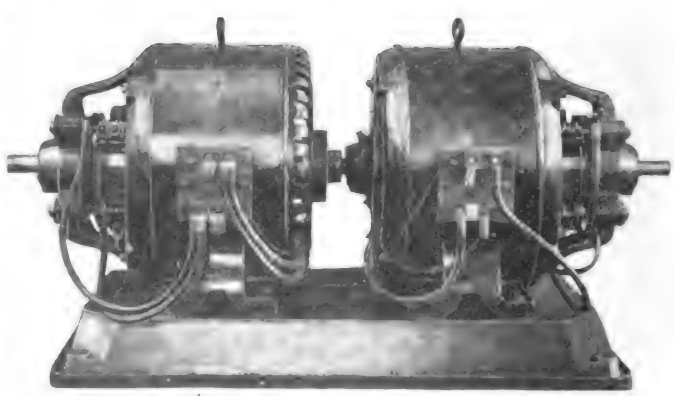


FIG. 60.

CONTROLLER AND BALANCER FOR BULLOCK MULTIPLE-VOLTAGE SYSTEM.

other twenty are obtained by varying resistance in the shunt field circuit of the motor. The total speed range is usually about $7\frac{1}{2}$ to 1.

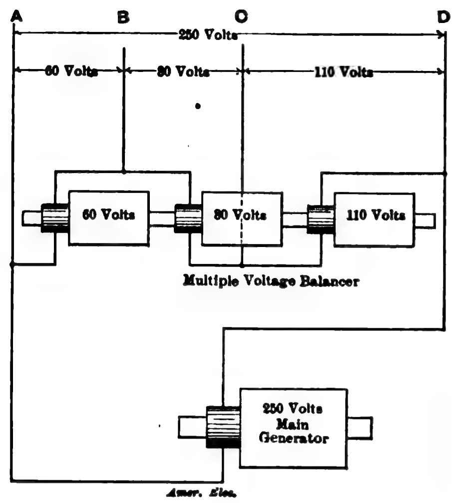


FIG. 61.—BULLOCK FOUR-WIRE MULTIVOLTAGE SYSTEM.

The Crocker-Wheeler Company also builds a multivoltage system in which the fundamental voltages are obtained by means of a motor-balancer. These are different, however, in value from those of the system just described, being 40, 80 and 120;

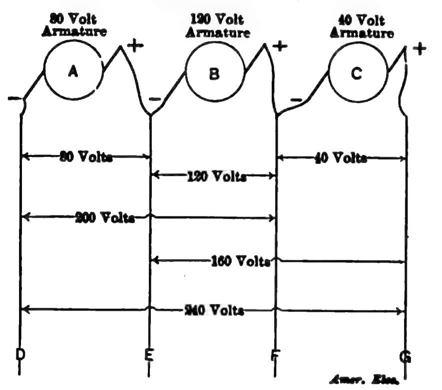


FIG. 62.—CROCKER-WHEELER FOUR-WIRE MULTIVOLTAGE SYSTEM.

combining the highest of these voltages with each of the lower ones gives 160 and 200 volts, and the e.m.f. between the outside wires of the system is 240 volts; see Fig. 62. The controller is of the usual

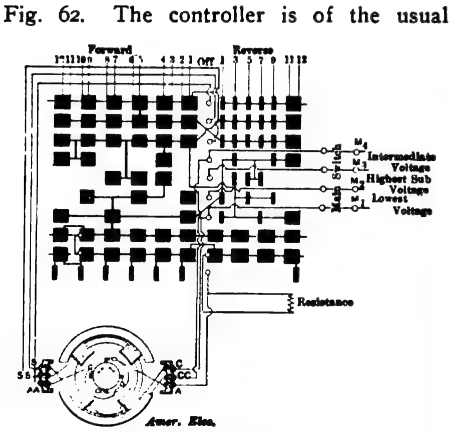


FIG. 63.—CROCKER-WHEELER CONTROLLER CONNECTIONS.

drum type, and gives twelve forward and seven reverse speeds. The intermediate speeds between the six obtained by the different voltages are obtained by a resistance in the armature circuit, field regulation not being used. All of the controller notches are running points; the first one puts the armature on the lowest voltage with the armature resistance in circuit; the second one cuts out the resistance; the third one shifts the armature to the second voltage with the resistance in circuit; the fourth one cuts out the resistance, and so on. The shift from one voltage to the other is made with a quick snap motion of the drum by means of a spring connection, so that the flashing at the contacts when the circuit is momentarily opened is reduced to a harmless value. Fig. 63 is a diagram of the controller connections and contacts; it will be noted that the reverse speeds, except the highest one, are the same as those forward speeds at which the armature resistance is in circuit.

When it is requisite that a finer speed gradation be obtained, the Crocker-Wheeler system is built with field-resistance regulation for the intermediate speeds, the armature resistance being used merely as a "buffer" at starting and when the armature is shifted from one voltage to the next. With this arrangement, any reasonable number of speeds may be had. The total range is usually 10 to 1.

The C. & C. Electric Company manufactures a multiple-speed motor system in which the motor has two armature windings and commutators, the two being connected in series or parallel by the controller. The system was designed originally with especial regard to the conditions to be met in the operation of large printing presses, but it has been found so well adapted to other purposes that it is in extensive use in dry-docks, manufacturing establishments, etc. The controller primary consists of a rheostat of the face-plate type, the arm of which is mounted on a spindle which also carries a spur gear that meshes with a segmental rack; the operating handle is attached to this rack, and the gear connection between it and the traveling brush of the rheostat permits a wide range of travel by the brush and a relatively short travel of the operating handle. Fig. 64 shows the arrangement described, the operating handle being shown separate from the

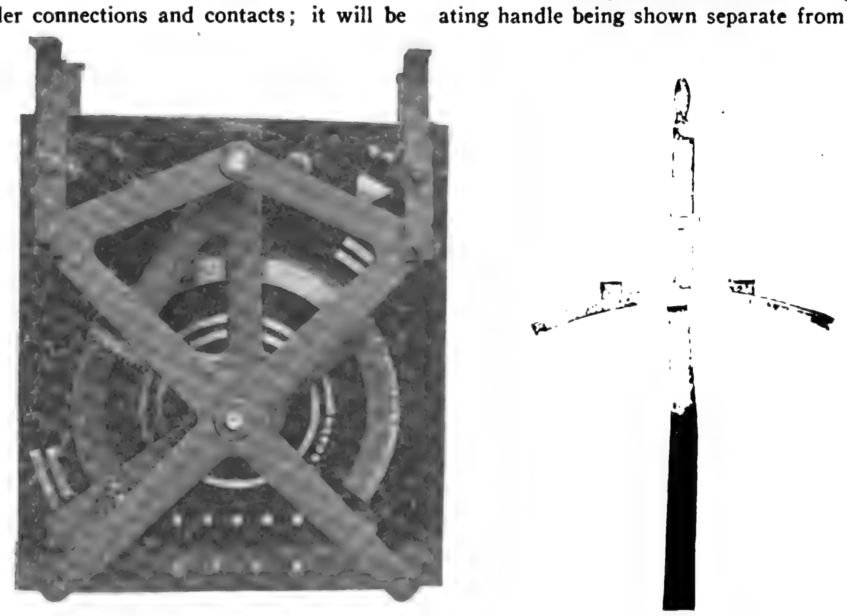
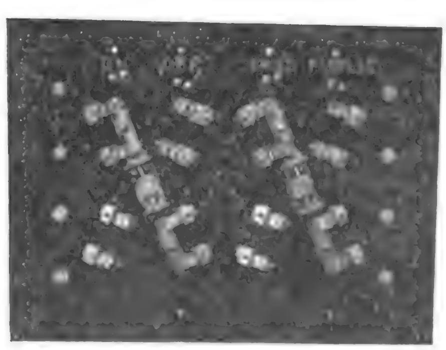


FIG. 64.—C. & C. SERIES-PARALLEL RHEOSTAT AND OPERATING LEVER.

rheostat; the rheostat here illustrated was designed for mounting on the ceiling of a room or pit beneath the pressroom, the operating lever extending through the pressroom floor to the segmental rack. The revolving arm on the rheostat cuts in and out resistance in the shunt armature field circuits of the motor and also connects and disconnects the windings of two solenoids which actuate switches for connecting the motor to the supply circuit and for connecting the two commutators in series or parallel.

Fig. 65 illustrates the panel carrying the two solenoid switches just mentioned; the left-hand switch connects the motor to the supply circuit and disconnects it, and the



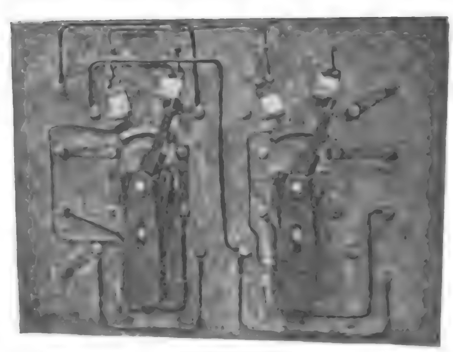


FIG. 65.—C. & C. MAIN AND SERIES-PARALLEL SWITCHES.—FIG. 66.

right-hand switch puts the armature windings in series or parallel. Fig. 66 is a view of the rear of this panel; each switch is actuated by a single solenoid, the linkage between the plunger and the switch arm

being such that the switch is thrown to the opposite position that it occupies when the solenoid is excited, no matter which position this is; moreover, it cannot remain in any position except one of the two extremes of its travel.

Referring again to Fig. 64, it will be noticed that there are two pairs of short arc-shaped strip contacts on the panel just outside the circle of rheostat contacts; one of these when bridged by the traveling brush on the rheostat arm closes the circuit of the main-switch solenoid and the other closes that of the series-paralleling solenoid. The two circular contact strips near the center of the panel are the shunt field connections, and the small buttons near the right-hand end of the outer strip are for the purpose of inserting resistance sections in the field circuit. The operation is as follows: When the controller lever is moved from the "off" position to the first notch on the quadrant, the rotating arm connects the main-switch solenoid to the circuit, and the switch is closed; it also puts the brush on the first armature-resistance contact and the motor is started at the lowest speed, which is a mere "crawl" for the purpose of "inching" the press. Further movement of the controller lever cuts out resistance in the armature circuit as usual. The series-parallel switch is at this time closed so as to put the armature winding in series.

When the rheostat arm has progressed far enough to cut out all of the armature resistance, the next step carries it to the point where it bridges the two strips which are connected to the series-parallel solenoid and the supply circuit, and simultaneously inserts enough resistance in the armature circuit to make the speed the same with the windings in parallel that it was when they were in series without any resistance. Further movement of the controller cuts out the armature resistance gradually, and when it is all out, the arm reaches the buttons in the field circuit and inserts resistance five sections of one at a time. When the controller lever is swung backward the reverse effects are produced, of course; as it passes the series-parallel solenoid contacts, it energizes that solenoid which throws the switch back to the series position; when it nears the original starting point, where all the armature resistance is in circuit, it closes the exciting circuit of the main-switch solenoid, which opens the switch, of course. The closing and opening of this switch are both accomplished with the armature circuit closed at the rheostat brush, so that there can be no arcing at the initial rheostat contact. The system also includes push-button stops, which may be located at any points and the closure of any one of which will excite the two switch solenoids and thereby cause the motor to be disconnected instantaneously and the windings to be put in series, ready for the next start. The motor then cannot be started up without moving the controller lever back to zero, because the main-switch solenoid cannot be excited until the arm bridges the contacts located at that position. If the motor is shut down by a stop button while the arm is beyond the point where it shifts the armature windings to parallel, moving it back past the series-parallel solenoid contacts on the panel will not throw the switch because the exciting circuit of that solenoid is "dead" when the main switch is open; the series-parallel switch remains, therefore, in the series position to which it was thrown by the closing of the stop button.

Another double-commutator system, extensively used for machine-tool, printing-press and other special classes of service, is that of the Commercial Electric Company, Indianapolis, Ind. In this system the motor has two armature windings and commutators, but the windings are not exactly alike, as in the case just considered. One winding has usually two-thirds the number of turns that the other contains; consequently, four fundamental speeds are obtained. With the two windings in series differentially (the smaller one opposing the larger) the maximum fundamental speed is obtained; with the smaller winding in circuit alone, the speed is about one-half the maximum; with the larger winding in alone, the speed is about one-third of the maximum, and with the two windings in series in the same direction, the speed is about one-fifth of the maximum. Intermediate speeds are obtained by varying a resistance in the shunt field circuit. The two armature windings have the same current-carrying capacity, so that the motor exerts full horse-power at all speeds. The controller is of the dial type, completely enclosed in a rectangular case which also contains the resistance coils and a starting switch operated by means of a separate handle on one side of the case; the speed-regulating handle is at the top of the case like that of the ordinary street railway controller. The regulating switch consists of an arm swinging about a pivot and carrying at both ends contact brushes which travel over a circular row of contact plates. On the front panel of the case are mounted the fuse-holders and an automatic double-pole circuit-breaker.

In conclusion, the writer desires to point out that the selection of the apparatus and systems herein described was made with a view to covering as nearly as possible the principal fundamental types, space limitations making it utterly impossible to describe every modification and alternative type. The lack of reference to any generally typical apparatus or system that has not been described is not due to any intention to discriminate, but solely to failure on the part of the maker to furnish the requisite material. The writer also extends thanks to those manufacturers whose kindly co-operation has enabled him to present the brief descriptions contained in this article.

Abstracts from Foreign Contemporaries

Cement-Covered Wood Poles.—R. W. Pope calls our attention to the fact that the idea of a cement-covered wooden pole is not as recent as the note on that subject published in this department last month would indicate. From references furnished by T. D. Lockwood it appears that as far back as 1835, Brunel suggested an easy way of defending piles, which was to give them a coat of tar, and then powder them with brick-dust which would render the wood sufficiently hard to receive a coat or two of cement. In "A Treatise on Dry Rot in Timber," by Britton, published in 1875, mention is made of wooden casings formed around poles, the intervening space being then rammed full of cement. Poles of cement were used in 1868 on the telegraph line from Aspinwall to Panama in South America.

A New Insulating Material.—E. Holthaus, in writing to the *Elektrotechnische Zeitschrift*, describes a new insulating material, named galalith, made by the Harburger Gummi-Kamm Co. It is prepared from skim milk, by a process on the whole similar to that employed in the production of ebonite. The result is a material having a structure which also resembles that of ebonite or horn. Water is first removed from the skim milk, the resulting product being hardened and then treated with certain acids, the material thus obtained being plastic. It is next pressed by hydraulic power into definite shapes, and is finally treated in a drying stove. Galalith is said to be from about 28 to 30 per cent. more elastic than ebonite, and is easily machined. Its density is about 1.4. With regard to insulation resistance and disruptive strength, it is somewhat inferior to ebonite, but it is stated to have a disruptive strength about equal to that of porcelain. This new material is not attacked by fatty substances, oils, benzine or alkalies, and is odorless. It appears that 60 litres (about 13 gallons) of skim milk are required for every kilogramme (2.2 lbs.) of galalith produced.

The Effect of Oil on Boiler Furnaces.—In a paper on "Boiler Furnaces and the Effect of Oil on their Ultimate Strength," recently read by Mr. D. B. Morison, before the Northeast Coast Institution of Engineers and Shipbuilders, the author said that if the surface of a furnace in a boiler for, say, 200-lb. pressure, were clean, the temperature of the metal would never reach the point at which its original tensile strength would be appreciably reduced, even under very high rates of evaporation. If, however, the surface were simply rubbed over with a very thin coating of mineral oil, the temperature would at once rise to 650 deg., even with a moderate rate of evaporation. An appreciation of this fact would explain many a so-called mysterious collapse of furnaces, in apparently clean boilers. If a mere coating of oil of inappreciable thickness would raise the temperature of the metal beyond the safe limit, it

followed that an extremely thin scale or deposit, containing a high percentage of oil, must inevitable result in dangerous overheating. A disastrous accident of this nature came under his notice some time ago, in which the furnaces collapsed. The boilers were apparently clean, with no appreciable scale on any part, and the principal cause of the accident was the use of a very inferior oil for swabbing the rods and lubricating the auxiliary engines. The oil becoming emulsified with the feed water, and being therefore unfilterable, passed directly into the boilers. Practically no oil was ever present in the harmless-looking deposit found on the crown of a collapsed furnace, simply because the temperature of the plate had been so high as to drive off the oil by distillation, but if deposit were scraped from other parts of the boiler, it would, on analysis, never fail to afford a solution of such furnace accidents as were sometimes termed "mysterious," by those who did not realize the dangerous effects of a very slight coating of deposit rich in oil.

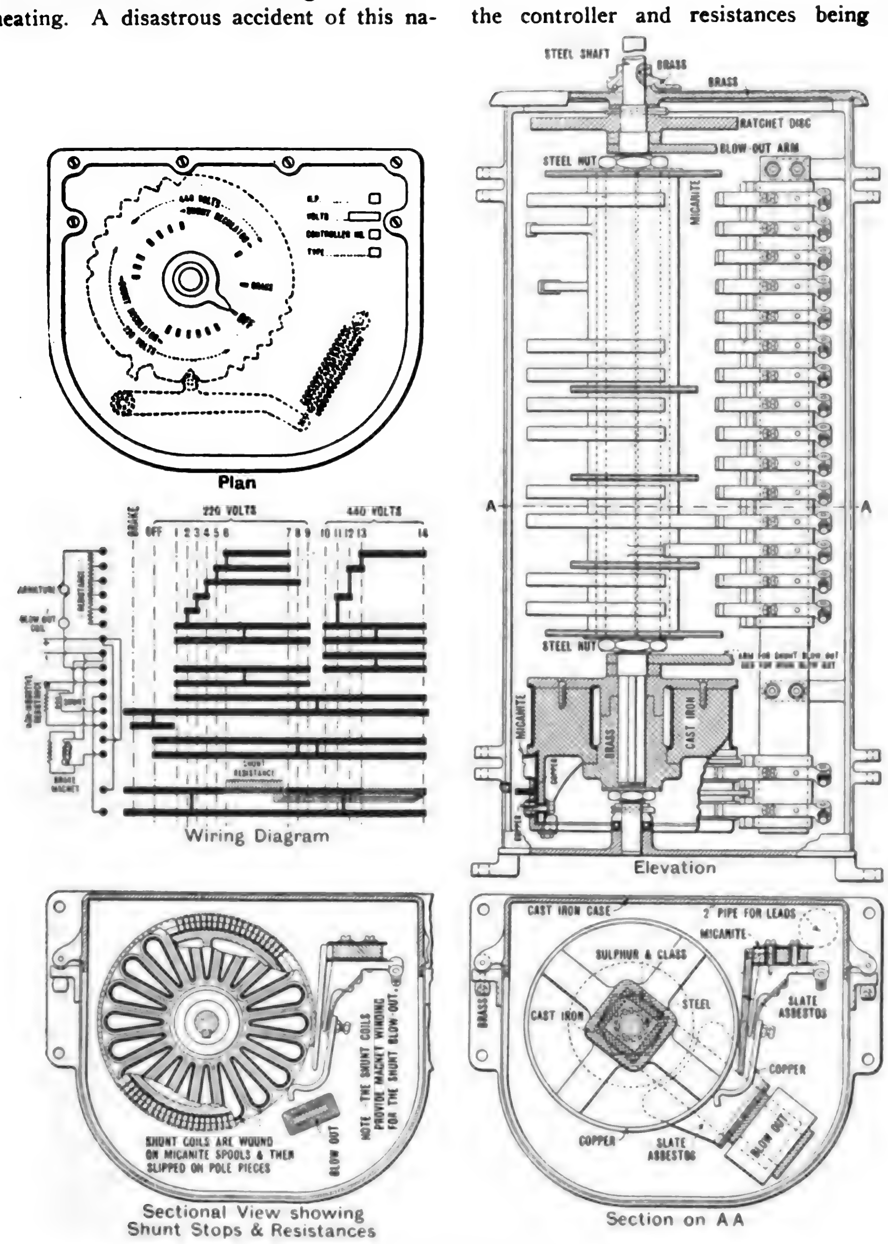


FIG. 1.—DOUBLE-VOLTAGE MOTOR CONTROLLER.

Double-Voltage Motor Controllers.—The London *Electrician* describes the double-voltage controllers used in connection with the variable-speed motors installed in the shipbuilding works of Harland & Wolff. The two voltages are 220 and 440, and a wide range of speed regulation is allowed, the controller and resistances being designed so that it can be left on any stop without injurious heating. For all sizes up to and including 15 horse-power the following cycle of operations will serve to illustrate the different speeds at which the motors may be run. The shunt is excited at 440 volts, and is switched on the mains just before the armature circuit is completed. Commencing from the "off" position and moving the controlling lever in a clockwise direction, the following obtains:

Off Position.
(1) Brake magnet excited—Brake lifted.
(2) Shunt resistance connected across kicking coil.

1st Starting Position.
(1) Ditto as regards brake magnet.
(2) Shunt excited across 440 volts and no resistance in series with its winding, giving maximum strength of field.
(3) Armature in series with all starting resistance across 220 volts.

2nd to 5th Starting Positions.
(1) and (2) Ditto.
(3) Armature starting resistance gradually cut out.

6th Running Position.
(1) and (2) Ditto.
(3) Starting resistance all cut out and armature direct on 220 volts, giving lowest normal speed.

Then follow 20 shunt regulating positions, resistance being inserted in series with the field winding. To obtain a further increase in speed the motor armature must be brought across the 440-volt mains. In order that the motor shall not have time to slow down, the next move must be made quickly. First, the shunt resistance is short-circuited to give a strong field, and then the armature resistance is inserted in two sections to reduce the arc formed on breaking before changing over to the first step on the 440-volt circuit. The next series of operations repeats that detailed on the 220-volt system with the exception that the armature resistance is cut out in three sections, giving four speeds instead of six, as on the lower voltage. By this arrangement no less than 40 different speeds can be obtained by shunt regulation. The controllers are fitted with contacts to which a magnetic brake can be connected, the shunt coil of the latter being de-energized when the controlling lever is moved in a counter-clockwise direction to a stop beyond the "off" position, thus allowing the gravity brake to act. The field winding is immediately short-circuited through a non-inductive resistance upon being cut off from the mains. In general appearance the controller is similar to that used on street cars. The shunt rheostat is self-contained in the controller case; but the armature resistance is separate, this being contained in enclosed ventilated iron boxes. The resistance consists of iron grids. The shunt rheostat is on a drum fitted in the base of the controller. The copper contacts are built up in the form of a commutator, while the resistance is wound on micanite bobbins, the wire used being double-cotton covered. The contact fingers are of hard-drawn copper, the links between these and the brass carriers being of laminated phosphor bronze. These carriers are carried upon and clamped to a mild steel bar rectangular in section, and are insulated from it by a micanite tube which fits over the entire length of the bar. Both armature and shunt contacts are protected by magnetic blow-out coils swiveled upon the main shaft; the shaft becomes one pole of the blow-out magnet, the magnetic path being directly across the point of contact of the fingers.

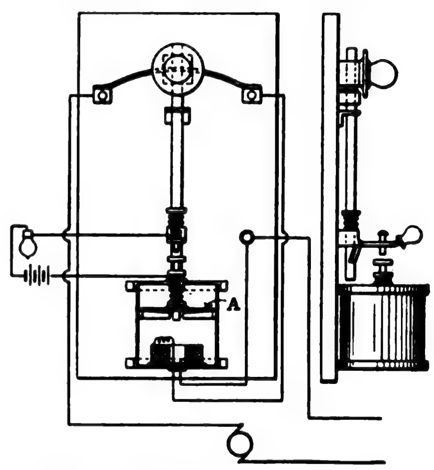
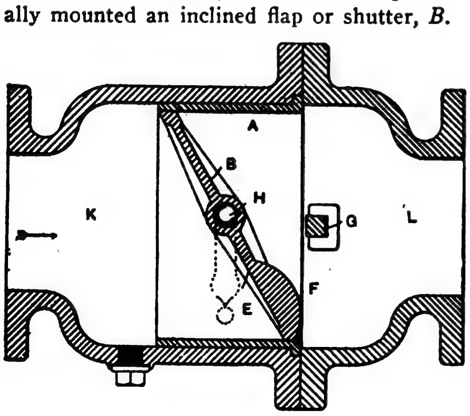


FIG. 2.—THERMAL CUT-OUT.—FIG. 3.

Time Element Thermal Cut-Out.—The thermal cut-out shown diagrammatically by Fig. 2 herewith, is described in a recent issue of the London *Electrician*. It is designed to act only after an over-load has

lasted a predetermined time. Its principal parts are a closed corrugated receptacle, *A*, of sheet metal, in the form of a disc, containing a quantity of ether and a small resistance coil placed underneath the ether receptacle, both being enclosed in a brass box as indicated in Fig. 3. The whole or part of the current in the circuit to be protected passes through the resistance coil, which begins at once to heat up, thus raising the temperature of the metal disc above it, and the coil may be so proportioned that its rise and fall in temperature with fluctuating current will be commensurate with the temperature variations in the electric apparatus it protects. For instance, when starting up a motor, it will take a given current a longer time to raise the temperature of the motor to a certain value than when the motor has already been warmed up. Similarly, a longer time will elapse before the air above the resistance coil assumes a given temperature after having completely cooled down than after having been heated up by previous service. As a rule, the resistance coil is so designed that about 8½ watts are dissipated per second during ordinary service at full load. When the overload comes on, the increasing temperature of the coil is communicated to the hollow metal disc and to the ether contained in it. The disc consequently bulges out and lifts a small piece of metal, which, in rising, first closes a bell circuit or a lamp circuit, and then, if the overload continues, actuates the trip gear of the main switch (see Figs. 2 and 3). By means of the screw adjustments indicated in the illustrations, the time element may be varied within wide limits. It will be noticed that the main switch cannot be closed again, after being tripped, until the resistance coil and ether disc have cooled down sufficiently. The device does not act, of course, instantly on a short-circuit, the shortest time being about some 10 seconds.

A Simple Design of Non-Return Valve.—Figs. 4 and 5 show sectional views of a non-return or isolating valve for steam pipes, which is described in the London *Mechanical Engineer*. The device comprises a chamber, *A*, in which is pivotally mounted an inclined flap or shutter, *B*.



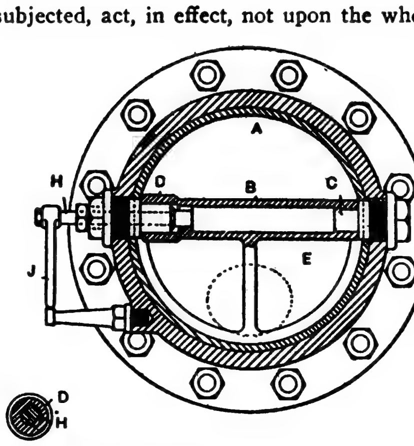


FIG. 4.—SIMPLE NON-RETURN VALVE.—FIG. 5.

The axis of the pivots, *C D*, between which the flap is mounted, is placed slightly out of centre, so that the area of the flap on one side of the axis is somewhat larger than that on the other side of the axis. The larger portion or wing, *E*, is weighted, as shown at *F*, with a view to imparting to the flap, *B*, a tendency to assume the closed position. Across the casing is arranged a stop, *G*, which serves to restrict the movement of the flap. Through one of the pivots, *D*, on which the flap vibrates passes a spindle, *H*, the inner extremity of which is formed as shown, so as to engage with the flap, *B*, in such a manner as to allow thereto a certain degree of free rotative movement. Upon rotating the spindle, *H*, beyond the limits of freedom so afforded it engages with the flap, *B*, and by its means the flap can be opened or closed. The outer extremity of the spindle projects through a stuffing-box, and is fitted with a hand-lever, *J*, whereby the spindle may be rocked. The inner extremity of the spindle may be so connected to the flap that the movements of the latter may be indicated by those of the hand lever, thereby showing whether the flap is in working order. Both the pivots, *C D*, may, if desired, be similarly fitted. The action of the apparatus is as follows: When the steam pressure upon the boiler side, *K*, of the flap is the greater, the flap opens by reason of its unbalanced condition, the area of one of its wings being greater than that of the other. When, however, the boiler pressure falls below that in the steam collecting pipe on the opposite side, *L*, of the flap, *B*, the reverse action ensues, the excess of pressure corresponding with the excess of area on one side of the axis of the flap causing the same to close automatically and to intercept the passage through the casing, thus preventing the return flow of steam. The ordinary pulsations of pressure, to which valves of the kind under consideration are subjected, act, in effect, not upon the whole area of the valve, but only upon the difference of area whereby one wing of the flap exceeds the other. Any violent or excessive vibration of the valve or flap is, under these circumstances, avoided when working under normal conditions. When, however, great difference of pressure suddenly arises—as, for example, in the event of a boiler, or a steampipe between the valve and the boiler bursting—the valve promptly closes.

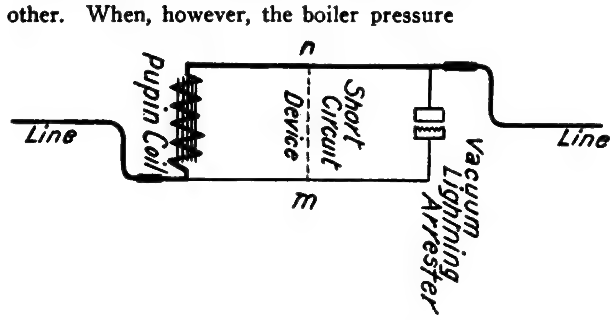


FIG. 6.—METHOD OF INSERTING COILS ON LIN

First Pupin Telephone Line in Austria.—The *Zeitschrift für Elektrotechnik* contains an illustrated article on the first Pupin telephone line in Austria, which connects Vienna with Innsbruck, the distance being 570 km. An ordinary telephone line would have required a bronze wire of a diameter of 4 mm., while with the Pupin system a bronze wire with a diameter of 3 mm. is sufficient, which means considerable saving of the first cost of installation. The transmission line comprises somewhat over 5 km. of underground cable. Pupin coils were inserted on the overhead line at intervals of 4 km. in both wires, each coil having a resistance of 1.2 ohms and a self-induction of 0.08 henry. The coils inserted in the cable line were constructed differently, and were placed at distances of 1,250 meters, having a resistance of 2.5 ohms and a self-induction of 0.2 henry. The way in which the coils were inserted in the lines is shown in Fig. 6. The short-circuiting device between *m* and *n* was used in order to make experiments on the efficiency of the Pupin system. It was thus possible to short-circuit any number of Pupin coils. The system was found to be quite successful, although it was found that half the number of coils was about as effective as the total number of coils.

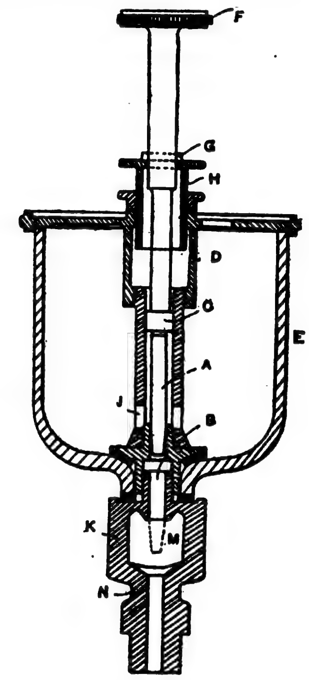


FIG. 7.—DRIP-FEED LUBRICATOR.

Improved Drip-Feed Lubricator.—The *Mechanical Engineer* describes the lubricator shown in section in the accompanying engraving. It is provided with a long conical spindle, *A*, arranged to slide vertically for a considerable distance in the feed passage, *B*, of the lubricator. The spindle, *A*, is in its upper part cylindrical and is a working fit in the passage, *B*, while an enlarged part, *C*, forms a piston which works in a cylindrical extension, *D*.

The upper part of the spindle extends outside the oil-storage vessel, E, and is provided with a handle, F. A pin, G, passes through the spindle, and is arranged to rest on the top of an adjusting screwed collar, H, which forms a neck bush for the sliding spindle. A slot is provided in the upper part of the screwed collar, H, so as to allow the pin, G, to pass downward. Holes, J, are provided in the cylindrical extension, D, and a space, K, is provided in the oil passage. By adjusting the height of the collar, H, the amount of opening to the oil may be readily set to meet the requirements of the bearing or cylinder. For the purpose of cleaning the spindle, A, is turned through a suitable angle, so that the pin, G, registers with the slot in the collar, H, and is thereby permitted to pass downward. The handle, F, is then moved up and down after the manner of a pump. This causes the piston, C, on its upstroke to draw oil in through the holes, J, and squirt it out again on the down stroke, whereby the holes, J, are cleaned of all sticky oil or dirt which may have been deposited there. At the same time the spindle, A, passing through the oil passage, B, to the position shown by dotted lines, effectively clears that passage of dirt or sticky oil by sweeping all such clogging material into the space, K, from which it may be removed by inserting the finger. As usual in such sight-feed lubricators the part, K, of the nipple, N, is provided with an opening, M, through which the drip of the oil may be seen and adjusted to the required amount. It is through this opening that the finger may be inserted for removing dirt. A glass tube may be provided to prevent ingress of dirt through the opening, M, to the oil supply passage, B. When the lubricator is not required the spindle, A, is turned as described above, and allowed to fall to its lowest position, when the piston, C, acts as a seal to shut off the feed.

Some Recent Electrical Patents

Motor-Starting Rheostat.—With a view to avoiding some of the disadvantages of the usual type of motor-starting rheostat with automatic no-load and overload release while retaining the safety features, Mr. Edgar F. Dutton, of Schenectady, N. Y., has devised the arrangement illustrated in partial diagram by Fig. 1 herewith. The main switch is an automatic circuit-breaker, equipped with a double detent, 17, which is pulled into the locking position shown by the solid lines when the shunt magnet, 18, is energized and drawn to the release position indicated by dotted lines when the load reaches the point where the series magnet, 24, overcomes the shunt magnet. The outer end of the detent is much heavier than the inner end, so that with no current on the line it falls to the release position. When in that position, it serves as a stop to prevent the closing of the main switch, and is lifted out of the way by moving the starting lever, 22, to the "off" position, where it bridges the contacts, 20, and thereby makes it possible to excite the shunt magnet, 18. The circuit to the shunt magnet is closed initially through the contacts, 20, and the extended jaws, 25, into which the auxiliary switch blades, 19, can be

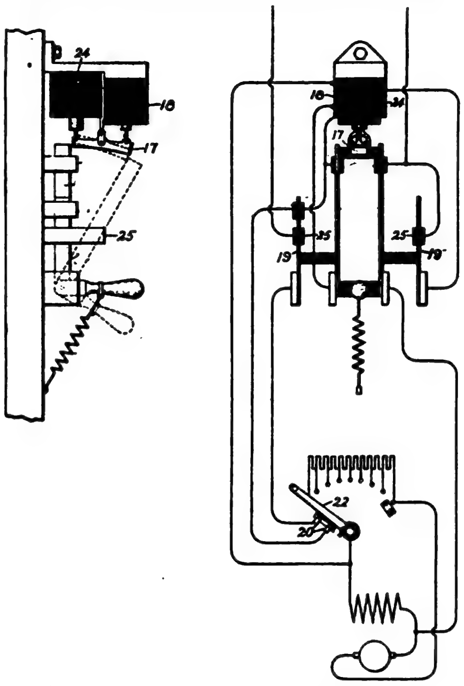


FIG. 1.—MOTOR-STARTING RHEOSTAT.

set before the main blades reach the stop, 17. After the main switch is once closed, the magnet, 18, remains in circuit regardless of the contacts, 20. The starting lever, 22, is provided with a spring to prevent its being left in an intermediate position, and is held in the running position by a friction clip or jaw located near the extreme right-hand button. Patent No. 786,017.

Printing Press Motor Controller.—It is well known to those at all familiar with the practical operation of large printing presses that when such a press is equipped with individual drive, means must be provided for turning the press very slowly—at a mere crawl—during the process of "making ready" or for threading in the paper of a perfecting press, as well as means for driving the press at ordinary speeds. One of the difficulties encountered in meeting these requirements with electric motor drive is that a motor large enough to drive the press at full speed cannot be controlled with absolute reliability at "crawling" speeds unless some very complex control system be employed; the remedy for this is to use a small motor for "threading" and "inching" and a large one for normal running, and this plan was adopted some years ago by the Cutler-Hammer Manufacturing Company, Milwaukee. With two motors, however, some difficulty has been experienced in shifting from the small to the large machine when driving a perfecting press; any sudden change in speed almost invariably tears the paper and makes it necessary to "thread up" all over again. In order to avoid this contingency, and to accomplish other desirable objects which will develop in the following explanation, Mr. H. H. Cutler, of the Cutler-Hammer Co., has devised the arrangement indicated by the accompanying diagram, Fig. 2.

The large motor, 26, is either coupled or geared positively to the driving shaft of the press and the small motor, 2, is connected to the shaft of the larger one through a magnetic clutch, 9, and reducing gears; the gears are required in order that the small motor may run at a rational speed while the press "crawls." The operation of the motors and controlling apparatus is as follows: When the rheostat lever, 31, is moved to the first contact, it also touches the contact, 71, and short-circuits the lamps, 69, which were in series with the solenoid, 65, and prevents it from lifting its plunger (this solenoid is always in circuit as long as the main switch, not shown, is closed, and the plunger of the solenoid, 51, is down). The solenoid, 65, immediately lifts its plunger and closes the circuit through the magnetic clutch, 9, thereby coupling the small motor to the press through the gears and the large motor shaft; the finger, 74, is lifted by the solenoid plunger, re-inserting the lamps, 69, in series with the winding, which is strong enough to hold up the

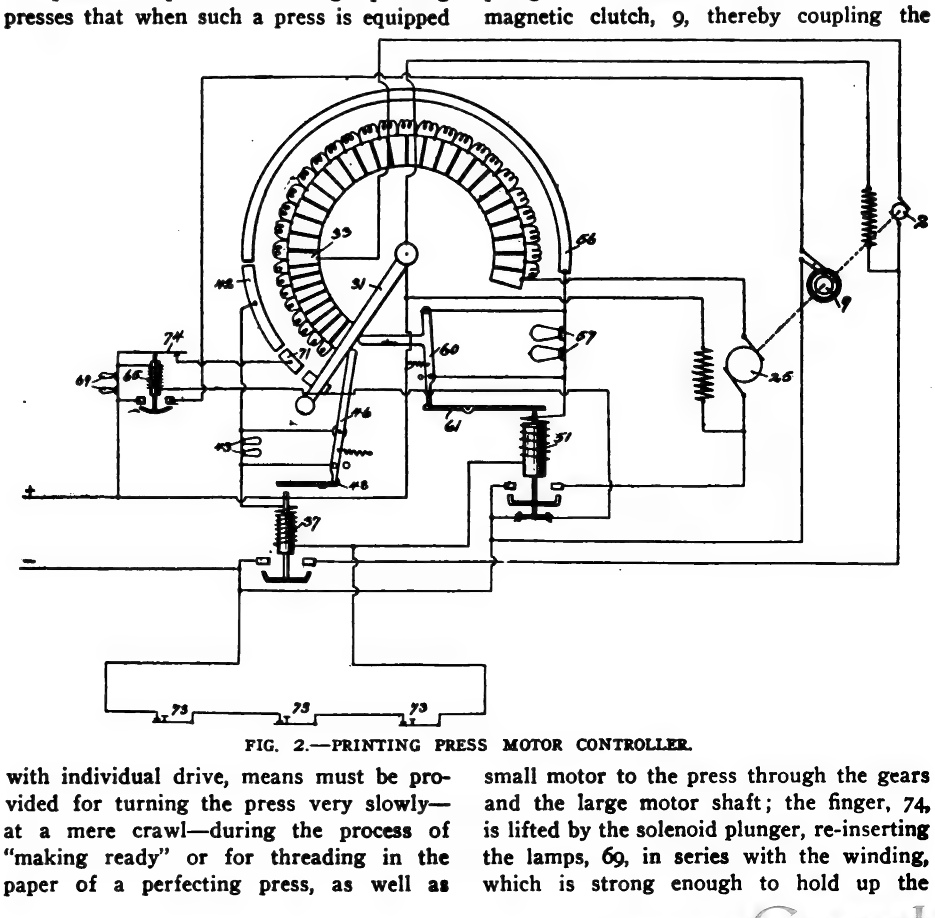


FIG. 2.—PRINTING PRESS MOTOR CONTROLLER.

plunger with the reduced current, but not to lift it from its lowermost position.

Further movement of the lever, 31, puts it in contact with the segment, 42, causing the solenoid, 37, to be energized and to close one side of the circuit of the small motor, which is closed on the other side to the armature through the rheostat and to the field winding direct. The motor starts up, and its speed is regulated by the rheostat up to the contact, 33, at which point it runs at its full speed. The plunger of the solenoid, 37, when drawn up as described lifts the latch, 48, and releases the lever, 46, which is pulled over by its spring and removes the short-circuit around the lamps, 43, putting them in series with the solenoid winding. Movement of the rheostat lever, 31, beyond the contact, 33, causes it to leave the strip, 42, thereby opening the exciting circuit of the solenoid, 37, and causing it to open the circuit of the small motor; just before doing this, however, it closes the circuit of the solenoid, 51, by touching the strip, 56, and that solenoid closes one side of the circuit to the large motor, the other side of which is already closed to the armature through the rheostat and to the field winding direct, as a tracing of the circuits will readily show. When the solenoid, 51, lifts its plunger, the lower contacts are opened, thereby opening the exciting circuit of the solenoid, 65, and cutting off the magnetic clutch, 9. This, of course, leaves the large motor driving the press, with the small one disconnected both mechanically and electrically; the rheostat and motors are so designed that when the large machine takes hold the press speed is practically the same as that given by the small motor when at its maximum, so that there is no jerk in the transition from one to the other. The large motor is brought up to full speed or any intermediate speed by further movement of the rheostat lever in the ordinary manner. When the solenoid, 51, lifted its plunger, it raised the latch, 61, allowing the lever, 60, to remove the short-circuit on the lamps, 57, and put them in series with the solenoid winding.

For stopping, one of the push-buttons, 73, is depressed, opening the exciting circuit of the solenoid, 51, and cutting off the large motor. Since lamps are in series with the solenoids, the motors cannot be put in circuit again by merely releasing the push button, 73, the solenoids being too weak to lift their plungers from the "off" position, though strong enough to retain them when once lifted. Before starting up again, therefore, the lamps must all be short-circuited, and this is accomplished automatically by swinging the lever, 31, back to the zero position, when it strikes the levers, 46 and 60, restoring them to the short-circuiting positions, where they are held by their respective latches. Patent No. 786.421.

CENTRAL STATION ENGINEERS.

VIII.

Paul Doty.

The subject of the present sketch was born in Hoboken, N. J., on May 30, 1867. After his graduation from the Stevens Institute of Technology in 1888 he entered the employ of the United Gas Improvement Company of Philadelphia, as a cadet engineer. In January, 1889, he was appointed assistant engineer of the Paterson Gas Works, acting at the same time as assistant engineer at the Jersey City Gas Works on special distribution work and construction. He afterwards returned to

PAUL DOTY.

the Paterson Gas Works and in January, 1890, was appointed assistant superintendent, in which capacity he continued until December, 1895. At that time he was appointed general manager of the newly organized Consolidated Gas Company of New Jersey, a corporation controlling the gas and electric interests in Long Branch and vicinity, including Red Bank and Asbury Park. He continued as manager of the Consolidated Gas Company about two years, when in December, 1897, he was called to represent Mr. Emerson McMillin, a capitalist, in the organization of the gas companies at Buffalo, N. Y. Having satisfactorily accomplished his work in the latter city, he went to Grand Rapids, Mich., as general manager of the gas light company there and in April, 1901, he accepted the position of general manager of the Detroit City Gas Company, Detroit, Mich., and the following month was elected secretary and a director of the company. His aspirations, however, still led him farther West and on September 1, 1903, Mr. Doty became vice-president and general manager as well as manager for the receiver of the Denver Gas & Electric Company, Denver, Colo., which position he still retains. Mr. Doty has been a frequent contributor to the technical press and has read many papers before scientific bodies. He is a member of the American Gas Light Association, Western Gas Association, American Association for the Advancement of Science, American Academy of Political and Social Science, ex-president of the Michigan Gas Association, 1902; member of the American Society of Mechanical Engineers, an associte member of the American Institute of Electrical Engineers, and ex-president of the McMillin Gas Companies' Association. In 1888 he was elected a permanent secretary of the Class of '88, Stevens Institute. Mr. Doty is also a member of many financial and social organizations. Yankee blood of seven generations courses through his veins, he being seventh in descent from Edw. Doty, who was numbered with the Pilgrim Fathers who came over in the Mayflower in 1620.

NOTES.

Brown Coal Operation in Producer Gas Plants.—A rather promising type of suction gas producer for operation with brown coal has been developed by the Deutz Gas Motor Works, and is described as follows: The producers consist of a pit oven open at the top and fitted with a grate below. The supply of air takes place both from the top and bottom, so that two burning ranges are formed. The gas that is evolved is sucked away at about half the height of the pit either by the engine itself or by a special suction blower, conveying it to a reservoir. The fuel that is filled in from above is first reduced to coke by contact with the incandescent coal lying below, after which it drops to the bottom, being completely gasefied in the lower part of the generator above the grate. The products of distillation sinking to the bottom during this process still contain a large quantity of readily condensible volatile hydrocarbons (tars) which are said to be decomposed completely into permanent non-condensible gases on their passage through the upper incandescent coal layer, thus becoming unobjectionable for engine operation. The generated gas is practically free from any tar on leaving the producer, so that all that is left is to separate in some suitable way any dust particles carried along and to cool the gas before it is used in engines. To accomplish this the gas is led through a water-sealed dustbag and a scrubber. It is claimed that in this plant any kind of crude brown coal, with a moisture up to 20 per cent., as well as brown coal briquettes, can be gasefied. According to the water contained by

the fuel, the air entering through the grate should or should not receive an addition of moisture, which by cooling the grate will prevent any objectionable formation of slag and by its conversion into water gas will augment the heating value of the generated gas.

American Society of Mechanical Engineers will hold its annual meeting this year at Scranton, Pa., on June 6 to 9 inclusive. A list of very important papers is announced.

The American Chamber of Commerce, recently established at Naples, Italy, includes among its members some of the largest firms in Italy and this country, so we are advised by the president of the Chamber, Mr. J. P. Spanier. The rooms are located at No. 10 Piazza della Borsa.

The New York Telephone Association.—The annual convention of the New York State Independent Telephone Association will be held on June 16, at Albany, N. Y. The sessions will take place in the Common Council Chamber of the City Hall, and an excellent program has been prepared.

Medina and Its Electric Power Plant is the title of a most attractive book issued by the A. L. Swett Electric Light & Power Company, Medina, N. Y. The company now operates two generating stations (water-driven) and a sub-station, the total output capacity of the generating plant being 3,000 horse-power.

Catalogues Wanted.—The American Consul at Prague, Bohemia, Austria-Hungary, writes that catalogues of American manufacturers of machinery and appliances of all sorts are greatly desired in his locality. All catalogues sent to him are carefully filed and a complete index of the collection is kept.

The National Electrical Contractors' Association will hold its fifth annual convention at Boston, July 15 to 23 inclusive, and there will be an important exhibition of electrical apparatus and appliances in conjunction with this meeting. The exhibition will be held under the auspices of the Electrical Contractors of Massachusetts, and the headquarters will be at Mechanics Building, where 83,000 sq. ft. of floor space will, it is stated, be available. Full information is obtainable from Mr. C. I. Campbell, 5 Park Square, Boston.

An Electrical Show will be held at Madison Square Garden, New York, from December 12 to 23 inclusive, under the auspices of the Exposition Company of America. There has not been an electrical exhibit in this city since the one held in conjunction with the Electric Light Association's convention in 1899, and in view of the strides that have been made since that time there should be available ample material with which to make the coming exhibition well worth while. Detailed information may be had from Mr. George F. Sever, Director of Exhibits, Room 903, No. 26 Cortlandt Street, New York.

International Association of Municipal Electricians will hold its tenth annual convention at Erie, Pa., August 29 to 31. The papers to be presented are as follows: "Electrical Induction, Its Effects and the Application of Methods Used to Counteract It"; "Advisability or Inadvisability of Fusing Fire and Police Telegraph Boxes"; "Suggested Improvements in Fire Alarm Telegraphs"; "Underground Construction"; "The Necessity of a Rigid Inspection by the Municipality"; "Electric Light Engineering"; "Electric Light Plants." These papers have been assigned to men who are thoroughly conversant with the subjects selected, and they are obviously of great importance to municipal electricians.

The York River Power Plant.—The weather being favorable, preliminary work to the erection of an electric power plant on the Susquehanna River, about a mile and a half below McCall's Ferry, has been taken up. This power plant is expected to supply current to Baltimore, Philadelphia and other cities and towns within similar range. The capitalists interested are New Yorkers and Philadelphians, and it is asserted that they already have invested nearly half a million dollars in buying up lands along both sides of the river.

The work of the engineers under Messrs. Eby and Anderson has been delayed during the past year, because of the fact that Mr. Eby was sent to Panama, and that Mr. Anderson, during a trip to his parents in Turkey, was imprisoned for some alleged utterances which were not pleasing to the authorities. Both have since returned to York County.

Substantial Power Plant Construction.—A frightful railroad wreck occurred on May 11, at Harrisburg, Pa., due to the collision of a passenger train with two freight cars loaded with 50,000 pounds of dynamite. The power plant of the Paxtang Electric Company, designed and built two years ago by J. G. White & Co., of New York, is located on the bank of the Susquehanna River, about 150 feet from where the explosion took place, and although more than 1,000 panes of glass were shattered to fragments, covering the generators and other machinery with minute particles of glass, careful examination has failed to show any other damage to the plant, which continued operation uninterruptedly. The force of the explosion may be imagined from the fact that heavy plate glass windows three miles away were demolished by the concussion. Upon hearing of the explosion, J. G. White & Co. immediately telegraphed an offer of any assistance that might be necessary to the electric light company, but none was needed.

A Novel Traffic Indicator.—An interesting apparatus for the indication of telephone traffic is in service at the main office of the Maryland Telephone Company, Baltimore. It consists of several rows of incandescent lamps mounted upon the wall opposite the chief operator's desk, two lamps being assigned to each operator's position. The lamps are 1-3 candle-power each and are operated by the pilot relays on the main switchboard. The upper lamp of each pair is white, and the lower one red. When a subscriber calls the central office the white lamp lights and remains lighted until the operator at that particular position plugs into the subscriber's jack, when it is extinguished. As soon as either subscriber hangs up his receiver the red light begins to burn and goes out only when the operator takes down the connection. By this device the chief operator can see at a glance the service being given on each position and can apportion the work among the different operators so as to avoid over or under loading. In a small monitor room adjoining is a reproduction of the traffic indicator on a smaller scale, set in the front of an expert operator's desk. This operator watches the service continually, going in upon one line and another and correcting defects in the service as occasion arises. The advantage of this method over inspection at long and regular intervals is obvious.

The Electric Light Convention.—As previously announced in these columns, the twenty-eighth convention of the National Electric Light Association will be held in Denver on June 6 to 11 inclusive. The program as thus far arranged is an extremely attractive one, both as to the serious sessions and as to the entertainment features. The business meetings will begin in the ballroom of the Brown Palace Hotel, Denver, on the morning of June 6. Entertainment and business sessions will continue until the night of June 8, and on the following morning those attending the convention will go to Colorado Springs for three days of entertainment. The following suggestions regarding railroad tickets may be of value: On the Union Pacific, Burlington and Rock Island roads tickets should read through Denver to Colorado Springs with stopover at Denver; on the Santa Fe and the Missouri Pacific they should read through Colorado Springs to Denver, with stopover at Colorado Springs on the return trip. This does not entail any extra expense; the railroads have agreed to the stopover. Low rates have been obtained, but they may go lower. Any of the three roads between the two cities gives good service. The scenery along the Short Line is superb, and as the train climbs the grade the visitors will be able to view the scenery for a distance of 100 miles. The big producing mines of Cripple Creek and the best of the electrical stations will be visited Those who desire to take the trip to Pike's Peak may do so on Sunday. This will be an optional trip, as will others that one may take to dozens of points of interest in and around Colorado Springs.

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Switchboard Illumination.

The proper illumination of a switchboard would seem to be one of the simplest questions to settle in laying out a small central station or an isolated plant, but a casual inspection of even recent installations will show that in many instances the subject has received but little thought on the part of whoever laid out the station. Switchboard lighting is of much more importance than might appear at first thought. The economical adjustment of the plant equipment to the load requires frequent reference to the switchboard instruments, of course, and it is essential that the illumination of them shall be bright enough and sufficiently concentrated to enable the attendant to see what they indicate without having to go to the board or even very near it. This is particularly true in plants of moderate size which are not justified in employing special attendants for switchboard work only, and in such plants poor illumination of the switchboard usually results in chronic carelessness as to the adaptation of the generating equipment to the requirements of the load. Since the steam consumption of a single-valve, high-speed automatic engine ordinarily increases from 30 per cent. to 40 per cent., at one-quarter load as compared with full-load consumption, it is important that wide changes in load should be noted promptly, and the influence of inadequate illumination of switchboard ammeters in discouraging continuous supervision of the load condition is really much greater than is commonly realized.

To a certain extent the illumination of switchboard apparatus is a problem very similar to that of lighting a picture gallery, and it should be treated separately from the lighting of the generating room, except that the latter should be so designed that the precautions for efficient lighting of the board will not be partly or wholly nullified. The best practice, of course, is to provide an individual incandescent lamp for each instrument scale and each circuit-breaker and a sufficient number to illuminate satisfactorily the other equipment on the board, all of the lamps being shaded on all sides except that next to the board. This advice will seem actually trite to many readers; nevertheless, plants have been very recently installed in which these simple precautions were not observed fully. In one case a 16-c.p. lamp was mounted on a bracket between each pair of ammeters throughout the length of the board, but where the panels joined the brackets were omitted. The results were that one-half of each ammeter scale was indifferently illuminated and the other half so shaded as to be unreadable from an appreciable distance.

The size of lamp suitable for switchboard illumination naturally depends on the size and arrangement of the apparatus, and to some extent on the material of which it is made—or perhaps more accurately, the finish put on that material. For individual lighting, an 8-c.p. lamp will usually suffice, and for general illumination of switches, etc., 16-c.p. lamps will always be large enough if intelligently distributed. The material and finish of the switchboard panels have a conspicuous effect on the efficiency of the lighting. In large plants of recent design a notable advance in this respect has been made in the use of panels finished in dull black instead of highly polished fronts of white or pink marble; the latter may look very pretty to the officials of the company on inspection tours, but they are most trying to the eyes of the men who have to look at them day after day—or night after night.

The Value of Electric Signs.

The Edison Electric Illuminating Company, of Boston, recently pointed out that the number of electric sign users in that city had increased more than three-fold within a period of eighteen months, and stated that its experience had conclusively demonstrated that the installation of one attractive sign in a neighborhood previously devoid of them invariably results in the installation of several more within a month after the first one starts up. This is due not merely to the power of example but also and largely to the fact that plentiful illumination brings trade to a mercantile establishment; stores that fail to keep up to the times in the matter of electric signs usually find it imperative to "come around" ultimately in order to prevent their progressive competitors from monopolizing their line of trade.

It has also been the experience and observation of the Boston Edison experts in this branch of work that in most cities and towns where the municipal restrictions as to electric signs were originally severe to the verge of being prohibitory the introduction of a few signs has revolutionized the sentiment of the city officials by reason of the conspicuous value of such installations to the city. Electric signs not only make the streets more cheerful and the business localities more attractive, but they serve to

discourage petty criminals from plying their vocations in the districts which would otherwise be the most profitable to them, the illumination being such a near approach to daylight as to make the conditions practically identical with those of the sunlight period.

In view of the foregoing facts, it would seem to be a good policy for central stations which have not exploited the sign feature to make special concessions in order to get the initial installation made. It should not be overlooked, however, that the after success depends almost entirely on the effect produced by the first sign; therefore, this one should be designed and installed with the utmost care. The design should be a strikingly attractive one without going beyond the limits of good taste, and every known precaution should be taken to make its operation reliable; an electric sign with an occasional lamp dark, or one that fails to light up at a critical time, is worse than none at all.

A Common Fault in Plant Layout.

Admirable as is the design of many a piece of engineering work in general conception and larger details, it is frequently true that the results fall short of what the designer probably expected because of the failure to recognize in advance that the highest economy of any installation of machinery, no matter how modern, cannot be obtained unless the layout is consistent throughout. This is frequently demonstrated in manufacturing establishments, for example, where a magnificent equipment of the most modern machine tools may be seriously handicapped by inadequate hoisting or conveying facilities, or by skimpy provision in even more minor details of the shop equipment. An actual case in point, but in another line, is that of a modern printing establishment in New England where each press is individually driven by an electric motor, and hundreds of dollars have been expended in order to obtain the advantages of motor drive. But instead of securing the full measure of cleanliness obtainable by the use of motors, as well as the maximum efficiency of the pressroom force, by lighting the premises electrically, the original gas jets have been retained to make life miserable in warm weather and prevent the ceiling from remaining white. Moreover, the fuse-blocks of the motors are in the basement instead of at conveniently accessible points in the pressroom, the wiring is exposed at the machine terminals and the switches are located at heights of two to five feet above the floor, with no coverings whatever. Many of the possibilities of such an installation in the way of unnecessary delays may be imagined, but a full realization of them is possible only in practice.

Minor Conveniences in Stations of Moderate Size.

There are several ways in which the work of attendants in sub-stations and medium-sized central stations may be facilitated and to some extent improved without involving the outlay of much money. For making out reports, filling in record blanks, etc., for example, a small table with a lockable drawer is far superior to the usual pine desk with a raising top, or the swinging shelf against the wall, and will always increase the employee's interest in his work. Liberal locker accommodations for the street garments and small personal effects of the employees will also prove a most profitable investment. The location of the telephone in a sound-proof and ventilated booth is a precaution which is of no little importance, to say nothing of the convenience to the station attendants who have to use the instrument; failure to hear promptly instructions telephoned to a station or information telephoned from it may easily cause a delay costing more money than a dozen of the finest booths that can be built. A small three-wheeled truck and a portable hoist for handling armatures, transformer parts, etc., should be in every station, no matter how small; the increased facility of handling an armature in a single emergency might prove an ample return on the difference in the first cost of such an equipment as compared with the usual chain hoist, intended to be "hung up somewhere" when needed. Excepting the telephone booth and the hoist, these conveniences are relatively small matters, but they will contribute a great deal to the contentment and efficiency of the employees, and their cost is insignificant in comparison with the results obtainable through them.

Concerning Name Plates.

So far as its operation is concerned, a dynamo or motor would be just as well off without a name plate as with one; yet there is probably no other part of the machine that is examined so carefully by visistors to a station or other interested persons not employed therein. And it is a matter of reasonable pride to the electrical engineer, being an indication of the thoroughness and precision with which his work has been done, that every piece of revolving and transforming apparatus for which he is responsible carries upon it this certificate of output ability, voltage, current, speed, etc. Of course, this is not the reason that name plates are put on dynamos, motors, converters, transformers, etc.; the chief object is to inform everyone interested in the matter just what the apparatus is intended to do, what its maximum output ability is and who made it (possibly the last-mentioned point should have been put first in the list). This method of imparting the information mentioned is not employed solely for the benefit of casual visitors, either; it is of prime importance to the operating staff of a station. It is not rational to expect employees to memorize the characteristics of every machine or important piece of apparatus about the plant, although most of them in time do so involuntarily, and it is highly essential that the fundamental data relating to any piece of apparatus shall be immediately available when required; the name plate meets this requirement perfectly—when it is properly made.

The foregoing argument applies just as forcibly to steam apparatus in an electric lighting or power plant as to the electrical equipment, yet no one ever saw a boiler name plate on which was stamped the number, diameter and length of the tubes, size of the grate, total area of heating surface, evaporating ability, etc.; nor does an engine name plate give the sizes of the cylinders, most economical point of cut-off, rating in pounds of steam per horse-power-hour at this cut-off and a stated initial pressure, or any other technical information beyond the so-called horse-power and preferred speed. In the case of pumps, the makers have gone a little farther ahead as to name plates and usually put on the cylinder sizes; it would be of considerable assistance to the user if the capacity in gallons per minute at the preferred speed were also put on, and the pressures for which the pump is designed might advantageously be included. The name plates on pumps for fire service are models of satisfaction in these particulars.

The point is that a great deal of valuable time is often lost by having to hunt up or calculate data which ought to be plainly stamped on the name plate of a piece of machinery; moreover, in the handling of machines equipped with incomplete name plates mistakes are made which would easily be avoided otherwise and which in some cases cause the machine to suffer disastrously for the petty sin of its builder.

HOW TO MAKE AN ELECTRIC BUCKBOARD.

BY J. C. BROCKSMITH.

The vehicle here described is of the buckboard type, in which the necessary cushioning effect usually obtained by means of springs is secured, partly through the resiliency of the tires and partly through the use of a frame or platform which gives a considerable elastic deflection under load. This permits of dispensing with springs and results in a much simpler and lighter construction all the way through.

A single motor is used in connection with a differential or balance gear of simple construction on the rear axle. Owing to the extreme lightness of the vehicle and the consequent small power required to run it, it would be inadvisable to subdivide the power into two units with a resulting loss in efficiency.

The battery used consists of 20 double cells, each having a capacity of 20 ampere-hours, thus giving 80 volts and 20 ampere-hours when coupled in series.

The controller provides three forward speeds of 3½, 7 and 12-14 miles, and a slow speed reverse of 3½ miles per hour with the normal gear ratio. At the normal speed of 12-14 m.p.h. the machine is capable of running 35 to 40 miles on one charge of the battery, over good roads. With a change of driving sprocket any speed up to 20 or 25 m.p.h. can be obtained without exceeding the one hour discharge rate of the battery. Higher speeds than the normal are only obtained, of course, at the expense of efficiency which results in a lower mileage due to the high discharge rate of the battery.

The outfit is designed particularly for city use over well-paved streets and with this in view the weights of the various parts have been reduced to the lowest possible limits. The weights of the various items and of the complete vehicle are as follows:

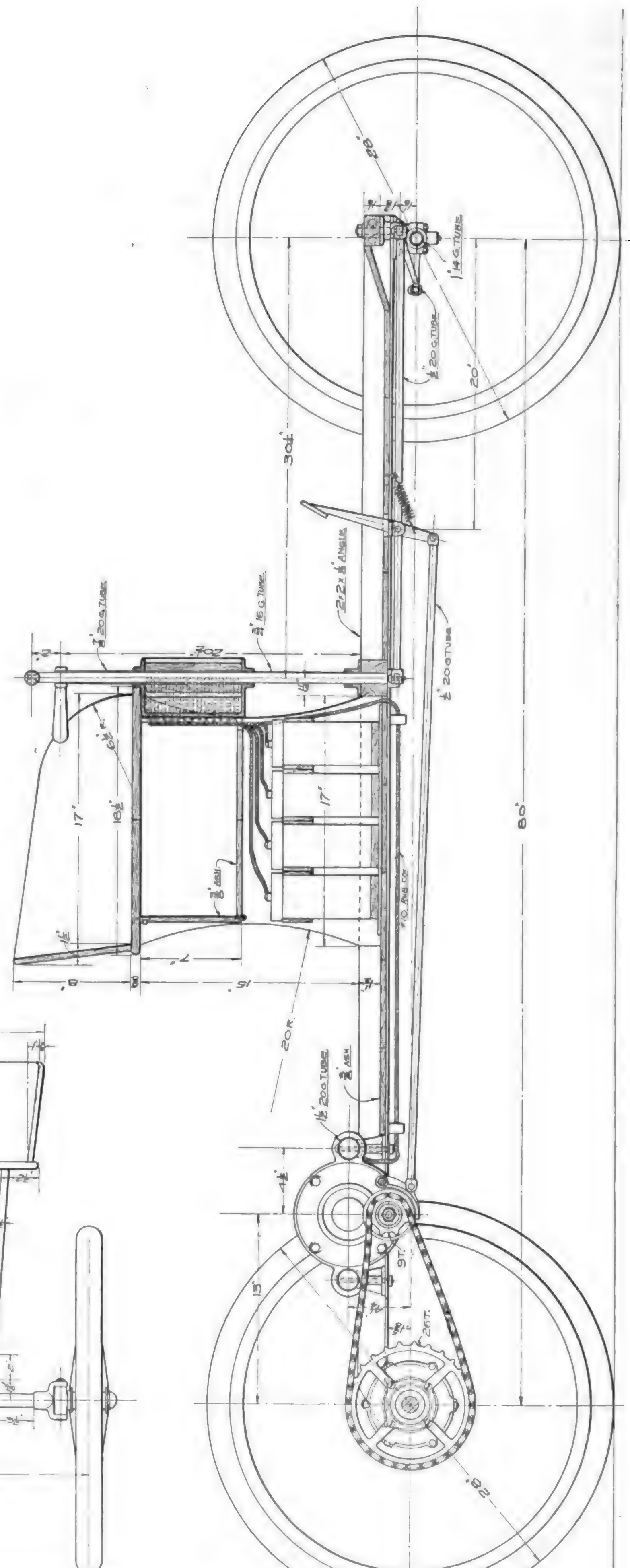


FIG. 1.—SECTIONAL ELEVATION OF ELECTRIC BUCKBOARD.

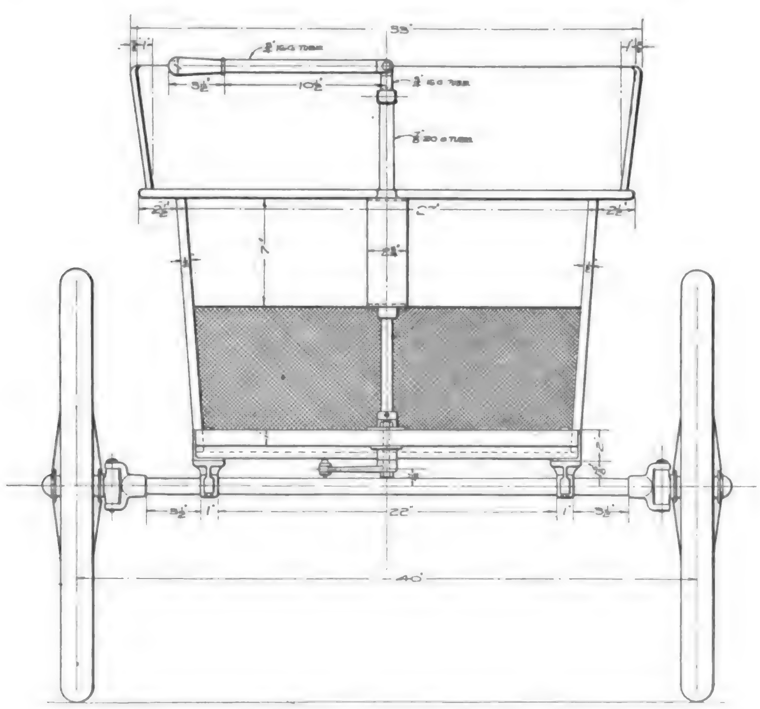


FIG. 3.—END ELEVATION OF BUCKBOARD.

Motor	38 lbs.
Battery	170 lbs.
Running gear	122 lbs.
Woodwork	45 lbs.
Total	375 lbs.

The Running Gear.

Fig. 1 is a sectional elevation of the complete buckboard and shows the mounting of the motor on the frame together with the method of driving by means of gears and chain reduction to the rear axle.

The wheels are 28 inches in diameter provided with 2-inch, single-tube, "motor cycle" tires and have 36 and 40 spokes of 12 and 14 gauge. The rims are of 28 x 2 maple. The "body" consists merely of a seat accommodating two persons, the space underneath being divided into two compartments by a horizontal shelf. The lower compartment is for four battery trays, while the upper compartment may be utilized for storing a tire pump, charging cable and such tools and accessories as may be required.

The controller, which appears in Fig. 24, is a small semi-cylindrical affair mounted on the front of the seat. The steering rod passes up through the controller cylinder and terminates in a steering handle or bar at a convenient distance above the floor line, the controller itself being operated by means of a smaller handle located concentrically with and just underneath the steering handle.

The brake pedal is located within easy reach of the operator's foot and connects with a brake shoe working on a drum on the motor counter-shaft, which, being geared, as it is, to the rear axle in the ratio of about 3 to 1, makes a very effective brake. As an extra precaution in case of emergency, the motor may be run in the reverse direction, but this is not advisable ordinarily as it puts a severe strain on all the transmitting parts.

It is hardly advisable to install any electrical instruments on a vehicle of this description as it increases the cost and also the wiring complications. It is well to have a small cyclometer of the "trip" type on the front wheel; this will enable the operator to keep within the known mileage capacity of his battery. It is useful to test the vehicle when first completed for speed, current consumption, etc.; but after such data are obtained there is no further necessity of having instruments on the machine. The tests should show up about as follows:

Controller.	Volts.	Amps.	Speed. M.P.H.
1	21½	5½	4½
2	41	7	9
3	80	9	15

Fig. 2 is a plan view of the chassis and shows the steering and brake connections, together with the motor suspension and drive, somewhat more plainly than in the previous figure.

The two side members of the frame are composed of 2 x 2 x ⅛ inch steel angles. These are figured to work well up to their elastic limit under load and consequently give a considerable elastic deflection which contributes to ease of riding. The angles are cut off 83 inches long and are drilled

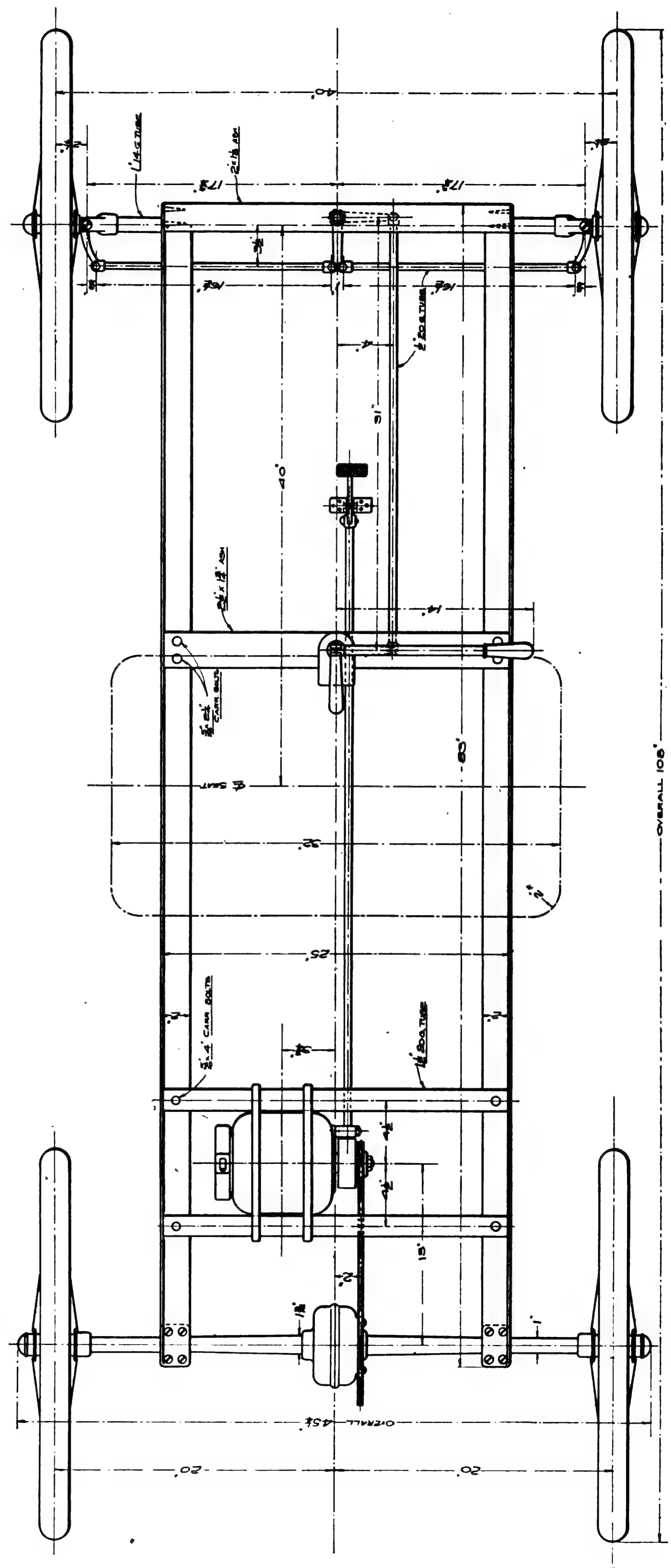


FIG. 2.—PLAN VIEW OF CHASSIS.

at each end for four 5/16-inch machine screws, which fasten on the axle bearings. They are also drilled and tapped at intervals to fasten the flooring, which is laid directly on the lower flanges of angles and secured by means of 10.24 flat head machine screws tapped into the metal.

Cross pieces of ash are provided at the front and near the center to serve as supports for the steering connections. Toward the rear there are two cross bars of 1½-inch 20 gauge steel tubing which support the motor. All of these cross pieces are bolted to the frame with 5/16-inch carriage bolts, the frame being drilled with holes properly located to receive them.

The motor must be located somewhat off the center, of course, in order to allow the differential gear to be placed in the center of the axle. Fig. 3 is a front elevation of the buckboard showing the location of the steering knuckles and controller, etc., and contains some dimensions relating to the seat which do not appear in other views. The front of the battery compartment under the seat should be covered with a screen of wire cloth or perforated sheet

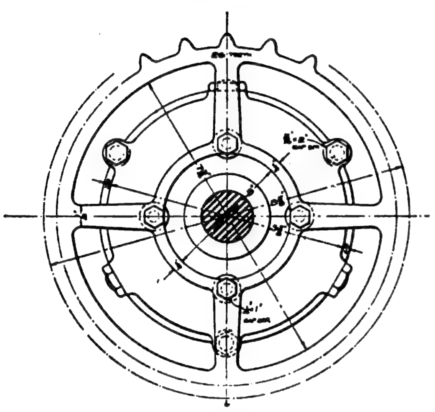


FIG. 5.—END VIEW OF DIFFERENTIAL GEAR AND SPROCKET.

metal, which permits ventilation of the battery and presents a finished appearance. The metal should, of course, be well painted to prevent corrosion.

Fig. 4 shows a semi-sectional view of the rear axle. The most satisfactory material out of which to make the axle is a bar of 1¼-inch nickel steel. The center portion is turned down to 1 3/16 inches, tapering to 1 1/16 inches just inside the bearings. From the bearings to the hubs the size is 1 inch. The bearings are of a standard size and type which can be purchased from any-one of several makers of ball bearings and are of the "grooved shaft" type, consisting of a tool-steel spool slipped over the shaft and two hardened rings fitting the case, one of which is threaded for the purpose of adjusting the bearing; 11/32-inch balls are provided in this size of bearing and these are satisfactory for the load and speed used.

The method of fastening the hub on the axle will vary somewhat with the type of hub selected. In cases where good-sized tandem or quad hubs are used, these are made threaded for a sprocket. A steel cap is made to fit this thread, the cap in turn being pinned to the axle. The axle within the hub is turned to fit the holes in

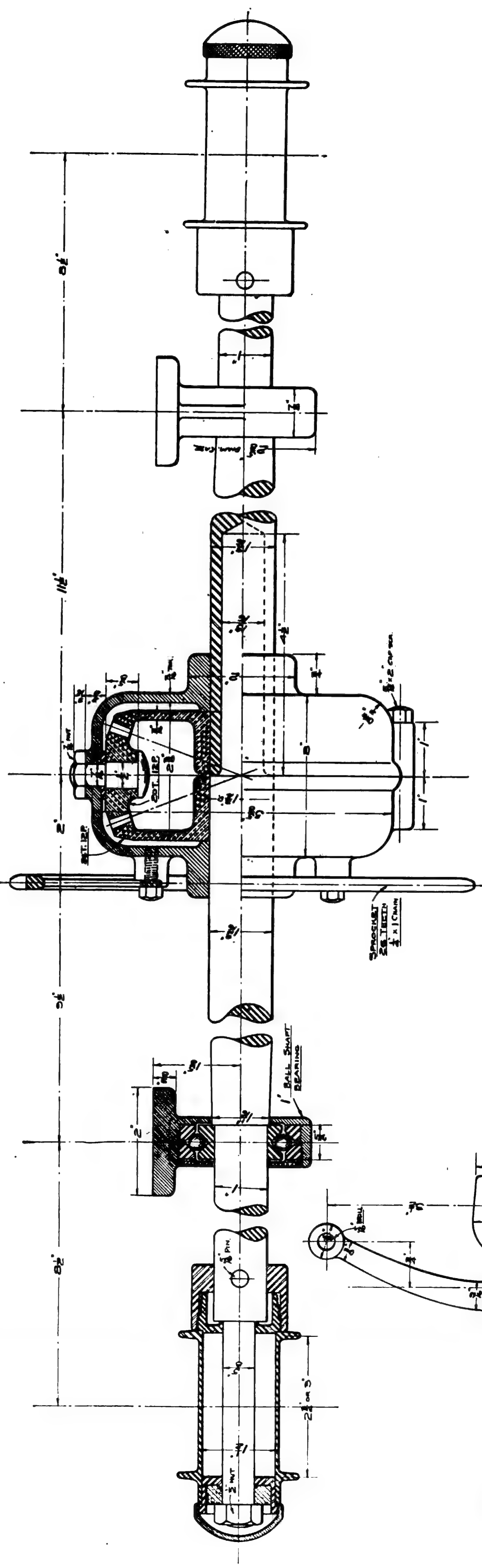


FIG. 4.—SEMI-SECTION OF REAR AXLE AND DIFFERENTIAL GEAR.

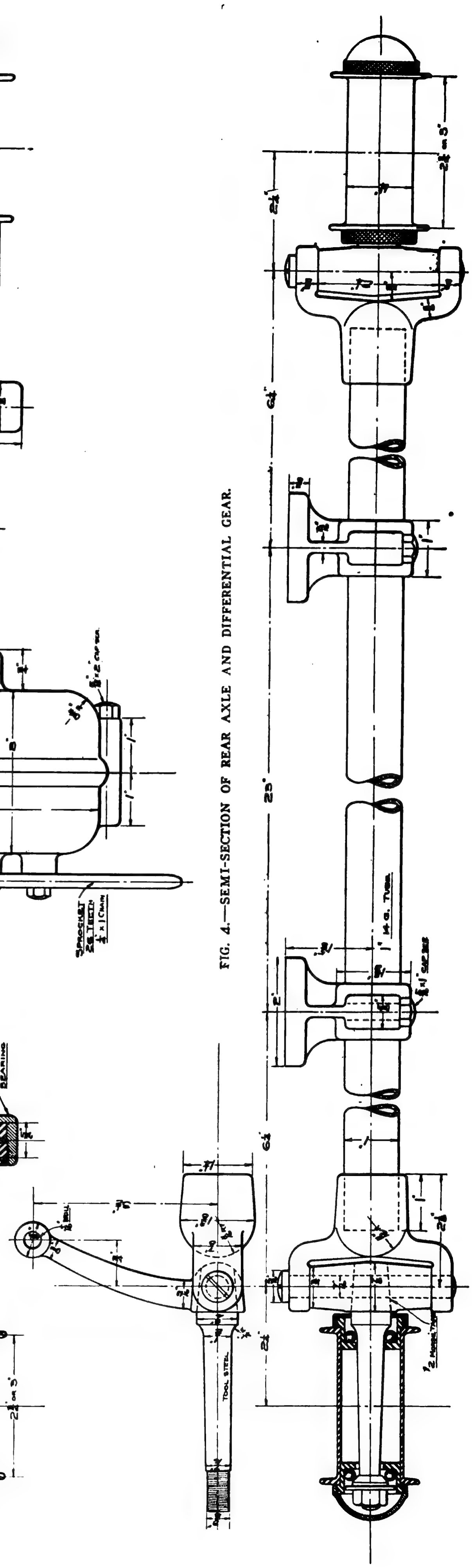
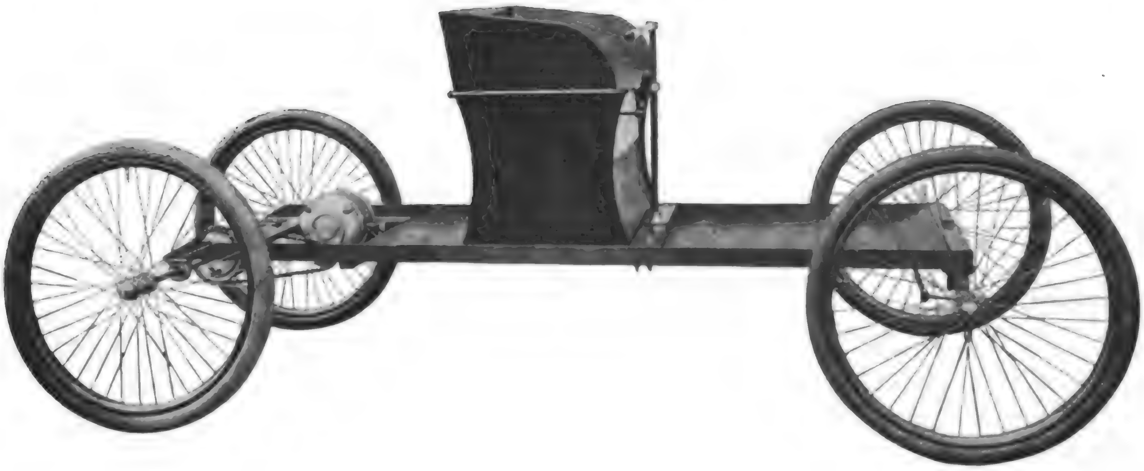


FIG. 6.—DETAIL OF FRONT AXLE.

the ball cups and provided with a nut and washer at the outside end.

In the center the axle is, of course, divided, one-half being turned down to 13/16 inch, which fits into a bored hole in the other half 4½ inches deep. Each half axle has a bevel gear keyed to it, which meshes with three bevel pinions secured on studs projecting through the gear case. These gears should all be cast of good phosphor-bronze and need not have cut teeth, cast teeth being good enough, providing, of course, that a good metal pattern with cut teeth is used.



SIDE VIEW OF ELECTRIC BUCKBOARD.

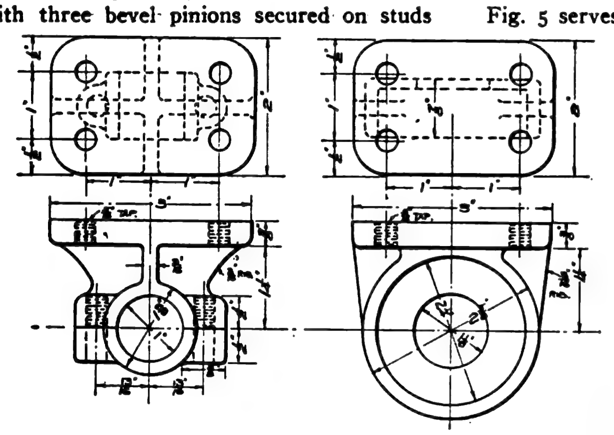


FIG. 7.—DETAILS OF FRONT AND REAR AXLE FITTINGS.

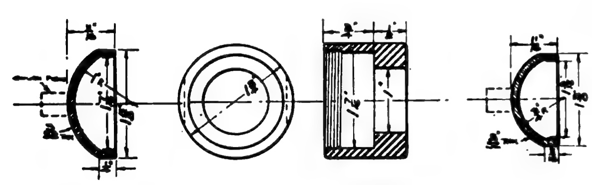
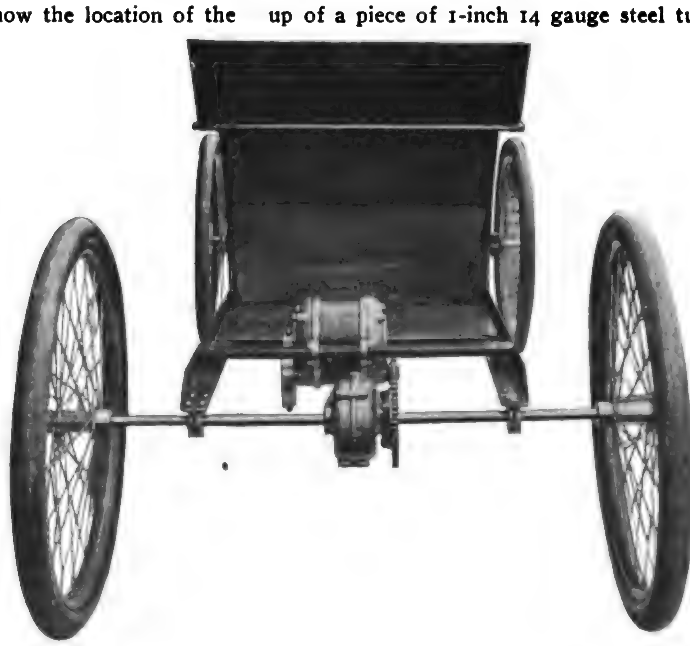


FIG. 9.—DETAILS OF HUB CAPS.



REAR VIEW OF ELECTRIC BUCKBOARD.

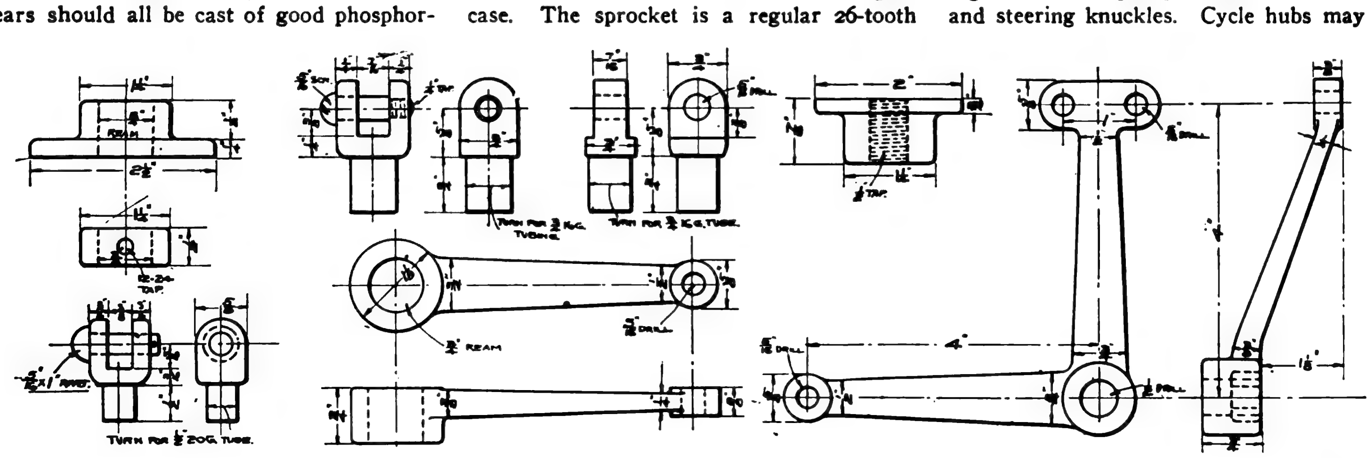


FIG. 8.—DETAILS OF STEERING GEAR CONNECTIONS.

The differential gear case is cast from aluminum alloy containing about 25 per cent zinc. It is provided with lugs at the side for bolting on the sprocket, and there are lugs on the periphery for bolting the two halves of the case together and also to form seats for the pinion studs.

Fig. 5 serves to show the location of the various bosses on the outside of the gear case. The sprocket is a regular 26-tooth bicycle sprocket with four arms and open center for ¼ x 1-in. chain. It has four holes for attachment to the pedal, but these are utilized in the present case for fastening it to the gear case. The most satisfactory chain to use in connection with this machine is one having nickel steel side links and hardened steel blocks and pins. Any chain of ordinary soft steel soon stretches and wears so as to be unusable.

Fig. 6 shows the front axle. This is built up of a piece of 1-inch 14 gauge steel tubing fitted with phosphor-bronze axle ends and steering knuckles. Cycle hubs may be used, a hub being selected which has a 7/16-inch axle. The cups on one side are reamed out to pass a half-inch rod. One-quarter-inch steel balls are used. The bear-

ing portion of the axle is turned from a ¾-inch bar of tool steel and the portion on which the balls run is hardened while the rest should be of much lower temper. The end of this axle stub is turned taper and fitted to the casting portion. The hubs are preferably of a type having the ends threaded for dust caps.

Fig. 7 shows the detail of front and rear axle bearing castings. Cast iron will answer for these, although malleable iron or steel would be better. The rear axle cases are bored and threaded to take the steel ball cones, and the front axle fittings are simply bored one inch and clamped in position on the tube by means of a couple of 5/16-inch cap screws. If tolerably smooth these castings need not be finished on top, where they are screwed to the frame. Four holes are drilled and tapped 5/16 inch for this purpose.

Fig. 8 gives the details of a number of small parts all relating to the steering gear. Their use and location will be seen from an inspection of the general drawings of the machine. These are all made of phosphor-bronze, and one is required of each except in the case of the small jaw casting, of which eight are wanted. There need not be any finish allowed on any of these castings except where as indicated on the drawing they are to fit the inside of tubing.

Fig. 9 shows the hub caps, which are made of the same aluminum alloy as the differential gear case and are finished bright. The steel caps for driving the rear hubs have already been described in connection with the rear axle.

The following is a list of the steel stock required to construct the running gear:

No. wanted.	Material.	Wanted for.
2 pcs.	83.2"x2x⅛ angle.	Frame.
1 pc.	50"x1¼" nickel steel.	Rear axle.
2 pcs.	4¾x¾ tool steel.	Front axle ends.
2 pcs.	15½"x½" 20G. tubing.	Steering gear.
1 pc.	30"x"½ 20G. tubing.	Steering gear.
1 pc.	28½"x¾" 16G. tubing.	Steering upright.
1 pc.	14½"x½" 20G. tubing.	Controller sleeve.
1 pc.	9¾"x¾" 16G. tubing.	Steering handle.
1 pc.	33½"x1" 14G. tubing.	Front axle.
1 pc.	43½"x½" 20G.	Brake rod.
2 pcs.	24¾"x1½" 20G. tubing.	Motor supports.

SOME THINGS ENCOUNTERED IN POWER PLANTS.

BY WM. CAVANAGH.

Upon taking charge of a going plant, an engineer usually wonders how "the other fellow" ever ran the equipment in any sort of satisfactory manner. However, now that he is in charge, he feels the obligation to put things in good running condition. One of the curious things he may find is that the fuses on the switchboard have a rating below the setting of the circuit-breaker, so that the fuses are almost sure to blow before the circuit-breaker will open. This is something that a practical man cannot quite understand. Another inconsistent feature that he is likely to encounter is the use of "open"-type motors in dusty or dirty places; this is especially common in iron works, foundries, etc. When a foundry has a finishing shop, tumbling barrels and emery wheels are employed in cleaning and rough-finishing the castings, and if there is any place on earth where open motors should not be installed it is such a place as this.

The atmosphere of a finishing shop is heavily laden with iron and emery dust, the one a good electrical conductor and the other a most efficient destroyer of the rubbing surfaces in machines; unless the motors in such a shop are frequently "blown out" thoroughly with compressed air, trouble is sure to result. The dust is so heavy that an ordinary hand bellows is practically useless; an air compressor must be used to supply the clearing-out air if the motors are to be kept in anything like proper condition. A pipe-line should be run around past the different motors, and supplied with air from the compressor; a hose connection should be inserted in the pipe-line at each motor for convenience in the use of the cleaning hose, as well as to reduce the length of it. Unless the compressor is equipped with a moisture eliminator, the compressed air will be charged with water; in order to make sure that moist air is not blown into the machines, air should be allowed to blow through the hose for several seconds before turning it on a motor.

In foundries and finishing shops, the heavy dust will cause the carbon brushes on the motors to wear away rapidly; on this account the tension of the brush springs should be carefully adjusted at frequent intervals.

Whoever invented or first suggested mounting motors on ceilings must have never enjoyed the pleasure of keeping them in good condition. Of course, the object in so mounting the machines is to economize in floor space, increasing the area available for work, but in practice this object is seldom realized. The much-valued space which would otherwise be occupied by the ceiling-mounted motors is usually filled with junk, and when an attendant finds it necessary to inspect a machine or make adjustments, etc., he must first remove the odds and ends lying around under it before he can set his ladder.

The "dust-proof" box that encloses a housed ceiling-mounted motor is usually just big enough to contain the machine, thereby preventing proper inspection, adjustments and cleaning. The rods that suspend the box from the ceiling and the braces employed to resist the belt pull or other strains further add to the difficulty of getting at the machine. Moreover, it will generally be found that the box is by no means dust-proof, but rapidly accumulates dust inside; this combines with oil drippings or leakage to form a compound extremely difficult to remove and one which, if left undisturbed, will surely result in spontaneous combustion ultimately.

Oil pans are fitted beneath the journal boxes of motors to catch the leakage, and these must be kept in good condition; if they are allowed to fill, they will overflow, of course, and may cause considerable damage. A syringe will be found very handy to use in keeping the oil level down.

The box around a housed motor is seldom equipped with a lamp socket, so that the motor attendant must carry with him a length of flexible cord, a lamp and socket at one end of it and an attachment plug at the other, in addition to his working tools and appliances. A great convenience in this sort of work is a white pine box about 18 or 20 inches long, 10 inches wide and 4 or 5 inches deep, with ½-inch walls; a handle should be located at the middle of the long side. Such a box can accommodate screwdrivers, pliers, an oil can, fuse plugs, tape, sandpaper and blocks, and clean wiping cloths; and if a few porcelain cleats and screws to fit them are included it will save many a trip back to the storeroom. The use of this box will be found immeasurably better than trying to carry in one's overalls the implements mentioned.

When the boiler room and engine room are located below the sewer level, the blow-off pipes, engine drips, waste pipes, etc., are connected to a receiving tank which is usually located in a pit or tunnel where very little room for inspection or repairs is available. This place is so filled with piping of every description that it is next to impossible to keep the connections in anything like decent condition. Should a leak occur in one of the under pipes, it necessitates the removal of numerous connections before repairs can be made; and all these must be restored, of course, after the repairs are finished.

The receiving tank is usually provided with a pump and pump-governor, supposed to keep the tank free of water automatically. The pump and governor being situated in such an inconvenient place, however, they seldom receive even half-way attention, so that the tunnel is extremely likely to become flooded with water at any time. When this does occur, the engine drips and exhaust drips become practically useless, and the conditions become dangerous, not to mention the great inconvenience of operation. Of course, the pump should be kept well packed and oiled, but it is doubtful if many engineers or assistants would care to risk being half cooked in order to do so.

Why a water main should ever be buried in a concrete floor is another obscure problem. Water mains so situated deteriorate rapidly and sooner or later develop leaks; the repairing of these of course necessitates digging up the floor.

When two or more engines are connected to a common exhaust main, a valve should be inserted in each individual exhaust pipe, preferably right at the cylinder if the engine is of the high-speed automatic type; without such a valve, it will be difficult to pack an idle engine on account of the exhaust steam backing through from the running engines. Under such conditions, it is advisable to put in a blind flange when any inside work is to be done on an engine; this is accomplished by opening the flanged connection in the engine exhaust pipe and slipping a piece of sheet iron and a rubber gasket in between the adjacent flanges. The iron and gasket must be of at least as large diameter as the outside of the flange, and

must have half as many bolt holes as the flange so as to permit closing the joint temporarily with half the total number of bolts. If the flange has more than eight holes, however, only four bolts may be used instead of half the total number, spacing the four as nearly equidistant as possible.

NOTES ON VALVES.

BY CHAS. L. HUBBARD.

Among the requirements of a good valve are sufficient weight of metal to prevent its being bent or sprung out of shape when connected with the piping; valve seats that are easily repaired or renewed; freedom from pockets or projections which may catch dirt or scale, and construction permitting the easy packing of the stem or spindle.

Gate valves offer very little resistance to the flow of steam or liquid passing through them and are generally used in the best class of work. The general construction of this type of valve is shown in Figs. 1 and 2, which represent the "inside" and "outside" patterns of the Chapman valve. In the former the spindle remains stationary, so far as any vertical movement is concerned, and the gate or plug being attached to it by means of a threaded nut rises into the bonnet when the spindle is revolved. With this form of valve it is impossible to tell by its appearance whether it is open or closed unless provided with some special indicating device. With the outside screw, the upper portion of the spindle is threaded and is operated by a revolving nut which is journaled in the yoke and turned by the hand-wheel. The operating screw of this valve is entirely outside the valve body, where it can be inspected and oiled, thus facilitating easy operation, and the spindle rises through the stuffing box without turning, which allows the packing to be kept tight without difficulty. With valves of this type the attendant can tell at a glance whether they are open or closed. For these reasons, outside-screw valves are preferable for high-pressure work and especially so for the larger sizes. In the case of low-pressure heating work, the inside screw is more commonly used. The Chapman gate or plug is made wedge-shaped and presses against ground seats when closed. The seats are made both solid and removable and of various materials for different pressures.

Gate valves of different makes vary chiefly in the smaller details of construction. In the Ludlow valve the plug or gate is made in two parts having their outer faces parallel, as shown in Fig. 3, instead of being wedge-shaped, as shown in Fig. 2. Between these two parts is a wedge with the thicker end at the bottom. When the valve is closed, the plug first descends and loosely closes the opening; then a further movement of the stem brings the two parts of the gate hard against the wedge, which forces the outer surfaces tightly against the seats. In certain forms of the Fairbanks valve the distinctive feature is a metal cage which holds the seat rings in place. With valves of this form the rings can be renewed by simply taking off the bonnet and without removing the valve from the pipe line. A special seat ring of vulcanized asbestos is used in this valve.

In choosing a valve, care should be taken to select one in which the material of the seat or ring is suited to the steam pressure to be carried. Bronze seats are commonly used for pressures over eighty pounds, unless the Babbitt metal or other material employed is especially prepared for higher pressure and is guaranteed by the makers. A gate valve should never be placed in a steam pipe with the spindle pointing down-

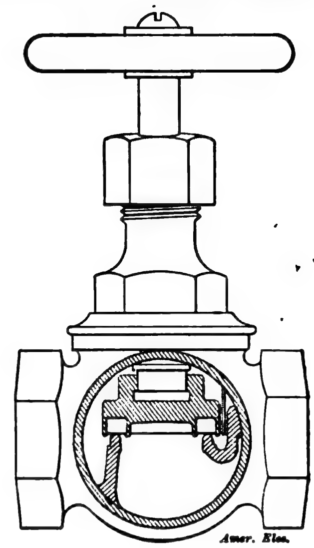


FIG. 5.—GLOBE VALVE.

ward, for when only partly open, the gate projecting from the bottom upward forms a pocket that will hold back the condensation and may thereby be the cause of serious injury to the plant. When placed with the stem extending upward or in a horizontal position, a clear passage is always provided at the bottom of the pipe. Valves are made in different weights and the pressure to be carried should always be stated in ordering them.

By-pass valves should be used in high-pressure work for sizes 8 inches in diameter and over. The two principal disadvantages corrected by the use of by-pass valves in high-pressure mains are, first, when the valve is closed there is an enormous pressure against one side of the gate, which makes it very hard to start; second, as the gate is pressed so tightly against the seat on the side opposite the supply source,

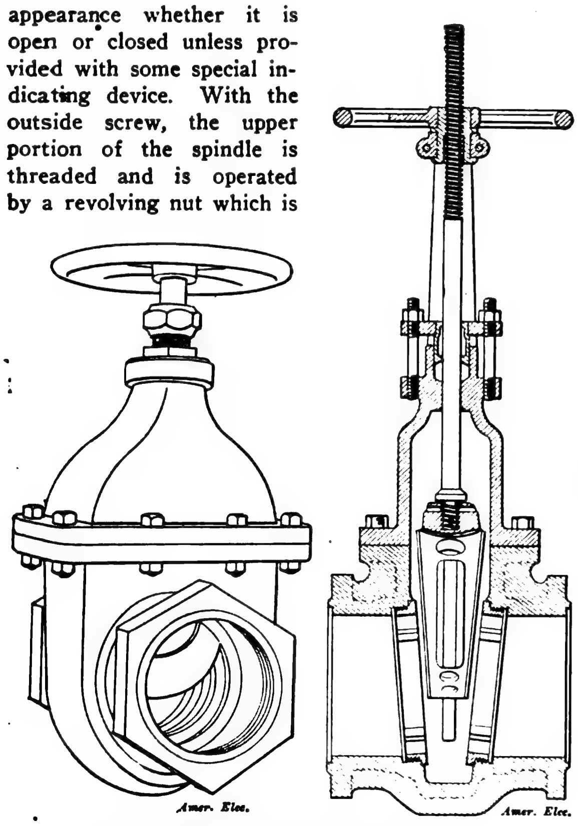


FIG. 1.—CHAPMAN GATE VALVES.—FIG. 2.

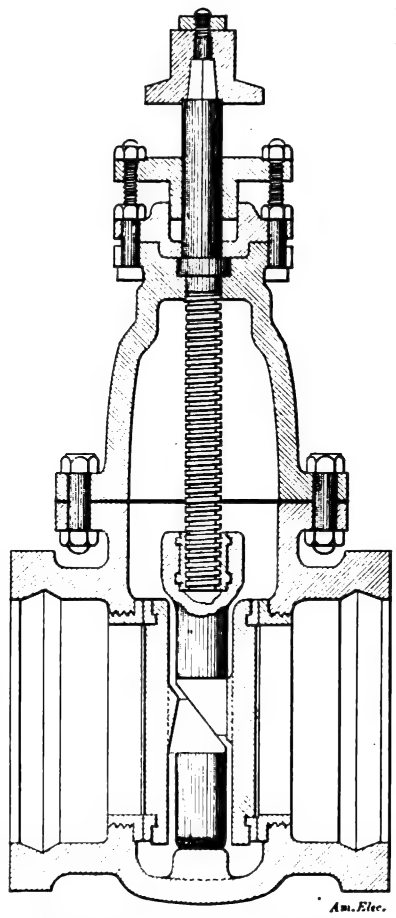


FIG. 3.—LUDLOW GATE VALVE.

FIG. 4.—FAIRBANKS GATE VALVE.

it is apt to score the smooth surfaces of the gate and seat when opened. Moreover, when the main valve is used in the supply pipe to an engine it is desirable to admit steam very slowly when "warming up" the engine, and this is much more easily accom-

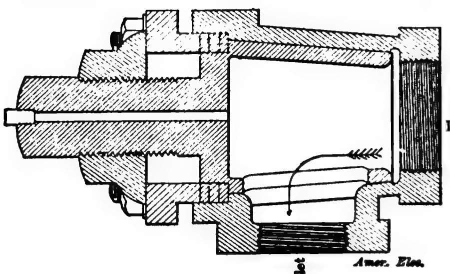


FIG. 6.—SHAW BLOW-OFF VALVE.

plished by means of a small easily-operated by-pass valve than by the use of the main valve.

Globe valves should always be set to close against the pressure, for if placed in the opposite direction they could not be opened if the valve should become detached from the stem, and no indication of the trouble would be given by the action of the stem under these conditions. Globe valves should never be placed in a horizontal steam or dry return pipe with the stem in a vertical position, because the condensation must fill the pipe half full before it can flow through the valve; this will be evident from an inspection of Fig. 5.

The blow-off pipe of a boiler is usually provided with a plug cock, and a gate valve is placed between it and the boiler as a safeguard in case of a leak. Special blow-off cocks and valves are sometimes used in place of the ordinary plug cock and valve. Fig. 6 shows the Shaw blow-off cock. This is made very heavy and so designed that it is difficult for dirt or scale to lodge beneath the seat. The difficulty experienced with the ordinary plug or blow-off cock is its liability to leak unless set down very hard against its seat, in which case it is apt to stick, especially upon "starting" it. To overcome this, certain forms have been designed so that after the cock is closed a further movement of the stem in the same direction forces the plug firmly against its seat by means of a cam located at the top of the plug. A slight movement in the opposite direction releases the cam and allows the plug to turn easily to the open position.

When it is necessary that the flow of steam or water shall always take place in the same direction, check valves are used. There are several forms of this type of valve in use, the most common of which is shown in Fig. 7. The seat in this valve is placed at an angle of about 45 degrees with the direction of the flow. The valve is fitted somewhat loosely where it is fastened to the swinging arm, so that it may properly seat itself. This form is usually preferred in heating work as it offers less resistance to the flow of steam or water and by its construction, offers but little opportunity for scale or sediment to lodge on the seat. When it is desired to reduce the resistance to a minimum, the check may be turned partially on its side, or a special aluminum clapper may be used. Spring checks are especially adapted for use in boiler-feed pipes where the water is supplied by a pump. The clapper being held in place by a light spring, it is prevented from beating against the seat between the strokes of the pump. Check valves are inserted in pipes at all places where it is desired to prevent the pressure in one pipe from "backing" into another, as when several return pipes from a building are brought into a common receiving tank. When used in a return pipe, the check should always be placed below the water line if possible.

It is often necessary to provide steam at different pressures in the same building, as in the case of a combined power and heating plant. In this case, the reduction in pressure is accomplished by passing the steam through a reducing valve. There are many different forms of these valves, the operation of all being based upon the same general principles.

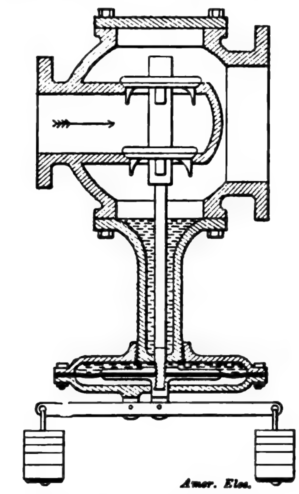


FIG. 8.—RIELY REDUCING VALVE.

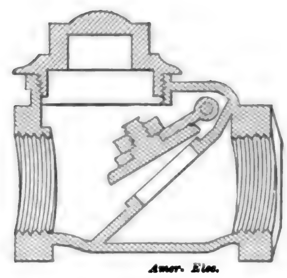


FIG. 7.—CHECK VALVE.

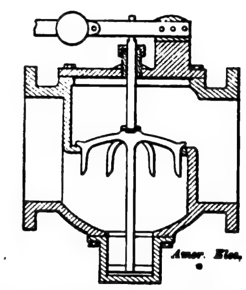


FIG. 10.—BACK PRESSURE VALVE.

In the Kiely valve, shown in Fig. 8, the low-pressure steam acts upon the top of a flexible diaphragm, and the weighted lever, which may be adjusted to give the desired

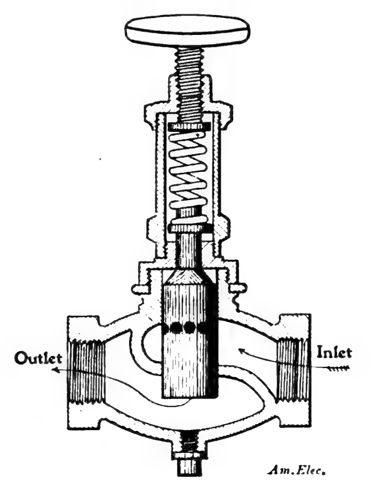


FIG. 9.—WATSON REDUCING VALVE.

reduction in pressure, acts upon the other side. The movement of the diaphragm causes the balanced valve at the upper end of the spindle to open or close, as may be necessary to maintain the desired lower pressure. In the Watson valve, Fig. 9, the reduced pressure acts upon the lower end of a piston valve having an adjustable spring at the top. As the piston simply passes through the inlet chamber its action is not affected by the high-pressure steam surrounding it. There are several good valves in use which embody the same principles, or a combination of the two. Those mentioned are among the simplest and are, therefore, appropriate for purposes of exemplification.

When the reduction in pressure is large, as in the case of a combined power and heating plant, the valve may be one or two sizes smaller than the low-pressure main into which it discharges. For example, a 5-in. valve will supply an 8-in. main, a 4-in. valve a 6-in. main, a 3-in. valve a 5-in. main, a 2½-in. valve a 4-in. main, and so on. For the smaller sizes the difference should not be more than one size. Every reducing valve should be provided with a valved by-pass for cutting out the reducing valve in case of repairs.

A back-pressure valve is a form of relief valve which is placed in the exhaust pipe from an engine or pump to prevent the pressure in the heating system with which it connects from rising above a given point. Its function is opposite to that of the reducing valve, which supplies more steam when the pressure becomes too low. The form shown in Fig. 10 is for a horizontal pipe and consists of a disc closing the port and held in place against the pressure by a weighted lever as shown. The pressure at which it is desired to have the valve open may be adjusted by moving the weight

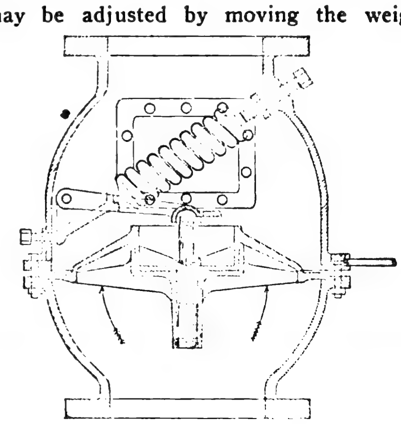


FIG. 11.—FOSTER BACK PRESSURE VALVE.

along the lever. In the Foster valve, a spring is used in place of a weight. This valve has a single disc moving in a vertical direction. The valve stem is in the form of a piston or dashpot which prevents a too sudden movement and makes it more quiet

in its action. The disc is held on its seat against the steam pressure by a lever attached to a spring. When the pressure of the steam on the underside becomes greater than the tension of the spring, the valve lifts and allows the steam to escape. The tension of the spring can be varied by means of an adjusting screw at its upper end.

DISEASES OF ELECTRICAL MACHINERY.

BY F. B. CROCKER AND S. S. WHEELER.

G. Speed too High or too Low.

This is generally a serious matter in either generator or motor, and it is always desirable and often imperative to stop the machine immediately, and make a careful investigation. This trouble may occur with either type of generator, due to Causes 1, 2, 3 or 4; with direct-current motors for Causes 5, 6 and 7; with series-wound, single-phase motors for Cause 7. It does not apply to synchronous or induction motors except when Cause 1 (overload) becomes excessive in which case they stop. (See following Class H.)

SPEED TOO LOW.

Cause 1.—Overload.

Symptom and *Remedy*.—See "Sparking," Cause 1, and "Heating of Armature."

Cause 2.—Short-circuit or ground in armature.

Symptom and *Remedy* the same as for "Heating of Armature," Causes 2 and 7.

Cause 3.—Armature strikes pole pieces.

Symptom and *Remedy* the same as for "Noisy Operation" Cause 2.

Cause 4.—Shaft does not revolve freely in the bearings.

Symptom and *Remedy*.—See "Heating of Bearings," all causes.

SPEED HIGH OR LOW.

Cause 5.—Field magnetism weak.

This has the effect, on a constant-potential circuit, of making a series or shunt motor run too fast if lightly loaded, or too slowly if heavily loaded, or even run backwards if the field magnet is not excited at all, as, for example, when the shunt field circuit is broken. It makes a generator fail to "build up" or excite its field, or fail to give the proper voltage.

Symptom and *Remedy* the same as for "Sparking," Cause 8. (See the following Cause; also "Dynamo Fails to Generate.")

Cause 6.—Too high or too low voltage on the circuit.

Symptom.—This causes a direct-current motor to run too fast or too slowly, respectively. It would have a similar effect upon a series or shunt-wound alternating-current motor. It would not affect the speed of a synchronous motor until the voltage became so high as to injure it or so low that it stopped. When the voltage of a generator or motor is too high it is likely to give the effects of overload (Cause 1). It can be proved by measuring the voltage of the circuit.

Remedy.—The central station or generating plant should be notified that the voltage or current is not right

Cause 7.—Motor too lightly loaded.

Symptom.—A series-wound motor on a direct or alternating constant potential circuit runs too fast and may speed up to the bursting point if the load is very much reduced, or removed entirely (by the breaking of the belt, for example).

Remedy.—Care should be exercised in using a series motor on a constant-potential circuit, except where the load is a fan, pump, or other machine that is *positively* connected or geared to the motor, so that there is no danger of its being taken off. A shunt motor should be used if the load is likely to be thrown off.

H. Motor Stops or Fails to Start.

This is an extreme case of the preceding class ("Speed Too High or Too Low"), but is separated because it is more definite and permits of quicker diagnosis and treatment. This trouble may occur in direct or alternating-current motors, but does not apply to generators, because any trouble in setting them in motion is generally outside of the machine itself, but might be due to Causes 1 and 2, below.

Cause 1.—Great overload. (See "Sparking," Cause 1.)—A moderate overload usually causes a motor (except the synchronous type) to run slowly, but an extreme overload will stop it entirely or "stall" it.

Symptom.—On a constant-potential circuit the current is excessive, and safety-fuse blows or circuit breaker opens. In their absence or failure the armature is likely to be burned out.

Remedy.—Open the switch instantly, reduce or take off the load, replace the fuse or circuit breaker, and turn on current again just long enough to see if trouble still exists; if so, take off more load.

Cause 2.—Very excessive friction due to shaft, bearings, or other parts being jammed, or armature touching pole pieces.

Symptom and *Remedy*.—See "Sparking," Cause 1; "Heating of Bearings," and "Noisy Operation."

Cause 3.—Circuit open, due to (*a*) safety-fuse blown or circuit breaker open, (*b*) wire broken or slipped out of connections, (*c*) brushes not in contact with commutator or collector rings, (*d*) switch open, (*e*) circuit supplying motor open, (*f*) failure at generating station.

Symptom.—Distinguished from Causes 1 and 2 by the fact that if the load is taken off the motor still refuses to start, and yet armature turns freely.

On a constant-potential circuit the field circuit alone of a shunt motor may be open, in which case the pole pieces are not magnetic when tested with a piece of iron, and there is a dangerously heavy current in the armature; if the armature circuit is at fault there is no spark when the brushes are lifted, and if both are without current there is no spark when the main switch is opened. When there is no field magnetism or even if it is weak, a motor is apt to be burned out if its armature is connected to the circuit, unless protected by fuses or a circuit breaker.

Remedy.—Open the main switch or circuit breaker immediately, and examine fuses, circuit breaker, wires, brushes, switch and circuit generally, for break or fault. If none can be found, close switch again for a moment, as the trouble may have been due to a temporary stoppage of the current at the station or on the line. If motor still seems dead, test separately armature field-coils and other parts of circuit for continuity with a magneto or a cell of battery and an electric bell to locate any break that may exist.

One of the simplest ways to find whether the circuit has current on it and to locate any break, is to test with an incandescent lamp, or several in series for higher voltages.

The remedy for a break in a direct-current armature winding was given under "Sparking," Cause 6. Similar expedients are applicable to alternating-current machines, the coil in which the break has been located being cut out by connecting together the adjacent coils. This may be done whether the break is in the armature or field coils. Furthermore, alternating-current machines are free from the danger of internal short circuiting which may occur in multiple-circuit direct-current armatures when a field coil is cut out (see "Sparking," Cause 9), because the armature winding is usually single circuit.

A single-phase motor is stopped by a break in its circuit, but a two or three-phase motor will continue to run as a single-phase motor if the circuit of one phase is broken. It is, however, more easily stopped, and is incapable of starting itself.

Cause 4.—Wrong connection or complete short-circuit of field, armature, switch, etc.

Symptom.—Distinguished from Causes 1 and 2 in the same way as Cause 3, and differs from Cause 3 in the evidence of strong current in the motor.

The possible complications of wrong connections are so great that no exact rules can be given. Carefully examine and make sure of the correctness of all connections. This trouble is usually inexcusable, since only a competent person should ever set up a motor or change its connections.

In the three-wire (220-volt or 440-volt direct-current) system several peculiar conditions may exist, as follows:

(*a*) The generator or generators on one side of the system may become reversed, so that both of the outside wires are positive or both negative. In that case a motor fed in the ordinary way from the two outside conductors will get no current, but lamps connected between the middle or "neutral" wire and either of the outside wires will burn apparently the same as usual.

(*b*) If one of the outside conductors is opened by the blowing of a fuse, an accidental break, or other cause, then a motor (220 volt) beyond the break can get some current at 110 volts through any lamps that may be on the same side of the break as itself, and on the same side of the system as the conductor that is open. These lamps will light up when the motor is connected, but the motor will have little or no power unless the number of lamps is large.

(*c*) If the neutral or middle wire is open, a motor connected with the outside wires will run as usual; but lamps on one side of

the system will burn more brightly than those on the other side, unless the two sides are perfectly balanced.

(*d*) If one of the outside wires becomes accidentally grounded, a 110-volt generator, motor or other apparatus also grounded and connected to the other outside wire, will receive 220 volts, which will be likely to burn it out.

I. Voltage of Generator too High or too Low.

This is a common difficulty that may arise with any machine. The particular case of the self-exciting direct-current generator is treated by itself under the following heading, "Dynamo Fails to Generate," because it is a perfectly definite condition like "Motor Stops or Fails to Start." The various circumstances that interfere with the generation of the proper voltage are here stated.

Cause 1.—Speed too high or too low.

Symptom and *Remedy*.—See "Speed Too High or Too Low," Class G, already discussed.

Cause 2.—Field magnetism strong or weak.

Symptom and *Remedy*.—See "Sparking," Cause 8, also "Dynamo Fails to Generate," various causes.

Cause 3.—Brushes not in proper position.

Symptom and *Remedy*.—See "Sparking," Cause 2, also "Dynamo Fails to Generate," Cause 6.

Cause 4.—Generator overloaded.

Symptom and *Remedy*.—See "Sparking," Cause 1, also "Speed Too High or Too Low."

Cause 5.—Short-circuited or reversed armature coils.

Symptom and *Remedy*.—See "Sparking," Cause 5.

Cause 6.—Open-circuited, short-circuited or reversed field coils.

Symptom and *Remedy*.—A break in the field circuit of a generator prevents it from producing any voltage except the small amount due to residual magnetism. A short-circuited field coil produces a corresponding reduction in ampere-turns, provided the field current remains constant. This would be true in the series coil of a series or compound-wound machine. In shunt-wound or separately excited field coils, however, the current would tend to increase in proportion to the decrease in the effective coils, in which case the field strength and voltage would remain the same. This condition is nevertheless bad, because the active field coils carry excessive current. (See "Heating of Field Magnets, Cause 1.") In machines with many field coils (for example, eight or more, including practically all alternating-current and large direct-current types) the cutting out of one, on account of an open or short-circuit in it, would not involve a rise in current likely to do harm.

One reversed coil would have the same effect as the loss of two coils, the field resistance and current being unchanged. Hence the current would have to be considerably increased by means of the field regulator to obtain the proper voltage, this increase being twice as great as for one short-circuited coil. A short-circuited or reversed field coil is very objectionable in a multipolar, multiple-circuit direct-current machine, as already explained. (See "Sparking," Cause 8, and "Dynamo Fails to Generate," Causes 2, 3, 4 and 5.)

Cause 7.—Lagging current in alternator. A direct-current or alternating-current generator, unless compound or composite-wound, tends to fall in voltage with increase in load (Cause 1) on account of armature resistance, inductance and reaction. This is usually overcome by raising the field current by means of a rheostat. In an alternating-current generator a given armature current produces much greater reaction and weakening of the field when it lags, so that the voltage fall and regulation required are correspondingly large.

REPAIR SHOP NOTES.

BY O. B. EVE.

Having noticed occasional articles in the American Electrician on methods of repairing and testing armatures and field magnet coils, it occurred to me that the following simple devices and methods might be of interest to some of the readers of this paper:

For testing out crosses in a commutator or an armature winding, I have found it a good plan to pass current through the armature by way of the regular brushes and to test each adjacent pair of commutator bars with a telephone receiver and a pair of contacts mounted on a block, as shown by Fig. 1. The brushes should be set exactly as they are for running, and the current controlled by some such means as a water or wire rheostat; ten amperes will usually suffice, and the current may be either direct or alternating. The armature may be mounted on blocks or in its bearings. If everything is clear, a distinct hum will be heard in the telephone when the contacts are pressed against two commutator segments; a cross between adjacent leads or commutator bars will cut out the humming entirely, while a cross within a coil will reduce it very perceptibly.

For testing out a ground, the terminals of the telephone receiver are connected to the two brushes of the machine and one of the brushes is connected to the frame (or the shaft, if the armature is taken out of the frame). The armature is then revolved slowly by hand, with current passing through from brush to brush; when the segment connected to the coil that is grounded

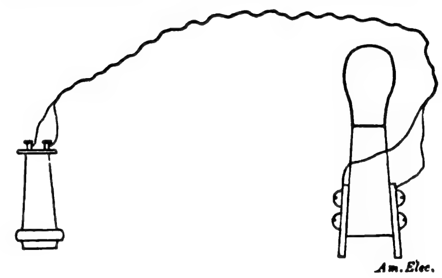


FIG. 1.

comes in contact with the ungrounded brush, the telephone will be short-circuited and the humming will, of course, cease.

These tests are reliable and have the advantage that a voltmeter is not required; the use of a voltmeter involves the difficulty of watching the instrument and the test contacts simultaneously, not to mention the expense of buying the voltmeter if you happen not to have one.

The arrangement shown in Fig 2 will be found very convenient and efficient for testing out short-circuits in field-magnet coils. It comprises a frame of laminated steel (transformer "iron"), the upper horizontal leg of which is removable. The core is 6 ins. x 8 ins. in cross-section and the horizontal pieces of it are 16 ins. long, leaving a clear space between the uprights of 4 inches. The bottom piece is held between two pieces of hardwood which are bolted together beyond the ends of the iron. The

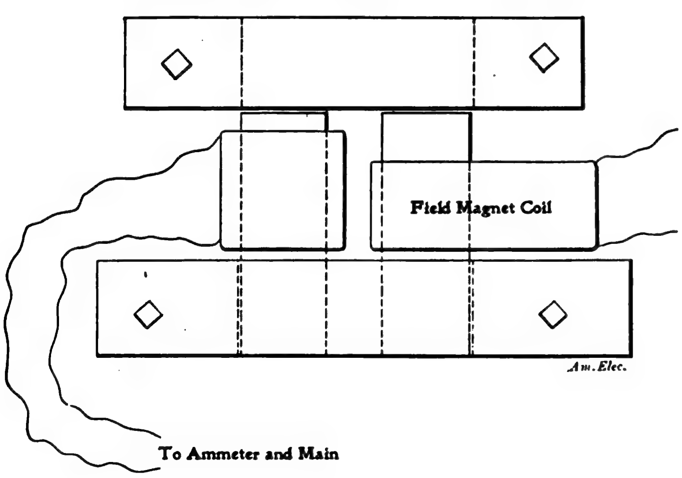


FIG. 2.

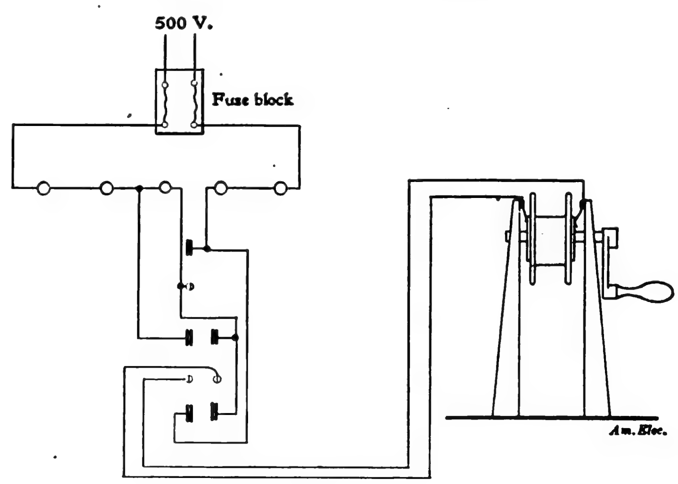


FIG. 3.

upper member is similarly mounted, and in this case the bolts near the ends of the wood cheeks serve as handles by which to lift the leg. A coil consisting of 60 turns of No. 5 magnet wire is slipped over one of the uprights and the field magnet coil that is to be tested is slipped over the other, as indicated roughly in the sketch. The magnetizing coil is connected to a 110-volt alternating-current in series with an ammeter,

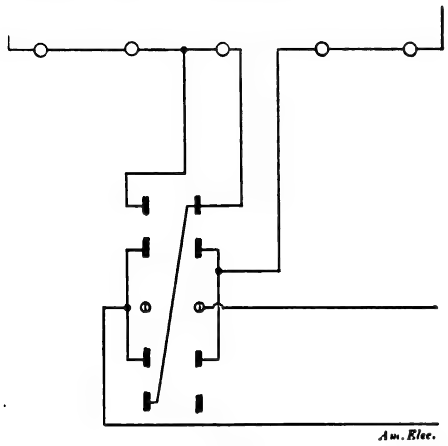


FIG. 4.

and if the field-magnet coil is sound, the ammeter will not show any more current with the field coil on the core than without it; any cross or short-circuit in the tested coil, however, will increase the ammeter indication, and if only a few turns are short-circuited the coil will immediately become hot.

Fig. 3 indicates a convenient method of taking either 100 or 500 volts from a 500-volt circuit for testing purposes. A double-pole, double-throw switch and a single-pole, single-throw switch are used to connect the testing leads either in series with a group of five (which are in series on the 500-volt circuit) or across the terminals of one of the lamps; the former connection, of course, gives 500 volts and the latter 100. The switches might advantageously be so mounted on a board that the handles would interfere with each other if not thrown properly, or a double-break switch might be used, as in Fig. 4; either plan would avoid any liability of an attempt to put the test leads in series with the lamps while the single-pole switch is closed.

The test leads are carried from the switch to two brushes on a reel frame which bear against slip rings on the sides of a reel, as indicated in Fig. 3; the inner ends of a duplex flexible cord are connected to the slip rings and the outer ends are carried to the work. The use of the reel avoids the nuisance of having a long length of cord lying about the floor when the work is near by.

In winding field magnet coils, two rollers located near the winding frame and arranged as shown in Fig. 5 will be found of much help in counteracting the tendency of the wire to bow outward away from the layer beneath it. In taping a coil, it will be found of advantage to provide a wooden

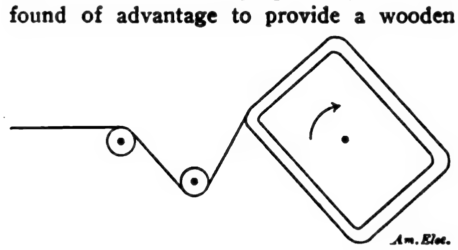


FIG. 5.

turn-table about 18 ins. in diameter surmounted by four blocks about 4 ins. square and 6 ins. long; the coil is laid on the blocks, and these are moved out of the way of the tape, one at a time, as the taping progresses.

EXTRACTING OIL FROM EXHAUST.

BY W. A. DOW.

In small steam plants where exhaust steam is used for heating purposes, little consideration is paid to the consumption of water or coal and a record of the maintenance or running expense is seldom kept. The plant is usually run more by guess than by actual figures. About twelve years ago the writer took charge of a plant, consisting of a slide-valve engine, one return tubular boiler, a boiler feed pump, a heater and receiving tank for the heating returns, and a small trap. The building was heated in winter by exhaust and live steam. But little thought was given to the economy and instead of returning the water of condensation to the boiler, it was trapped from the receiving tank to the sewer. My predecessor informed me that his reason for doing away with the returns was that he did not feel that it was safe to return it to the boiler on account of the oil in the exhaust steam, and the company would not install an oil extractor. I thought this a very poor excuse and decided to first get rid of the oil in the returns and then return it to the boiler. The apparatus I used is shown in the accompanying sketch. The exhaust steam enters the heater, *S'*, through the pipe, *O*, and passes out through the pipe, *S*, to the heating system, the returns entering the tank, *N*, through the pipe, RR_1. When the condensation accumulates and partly fills the tank, it runs out by gravity into barrel No. 3, passing out at the bottom and entering barrel No. 2, passing out of No. 2 at the bottom and entering barrel No. 1 at the top. It will be seen that a float is placed in the first barrel and hinged to the side of it at *F*. A bracket was made fast to the inside of the barrel that acted as a guide to the valve steam, *U*, shown at *B*. A joint is placed in the stem at *T* so that the stem below the bracket can move in a straight line when the float is raised or lowered by the action of the water in the barrel. The thread on a globe valve was filed off, so as to allow the stem free movement in the bonnet of the valve; this

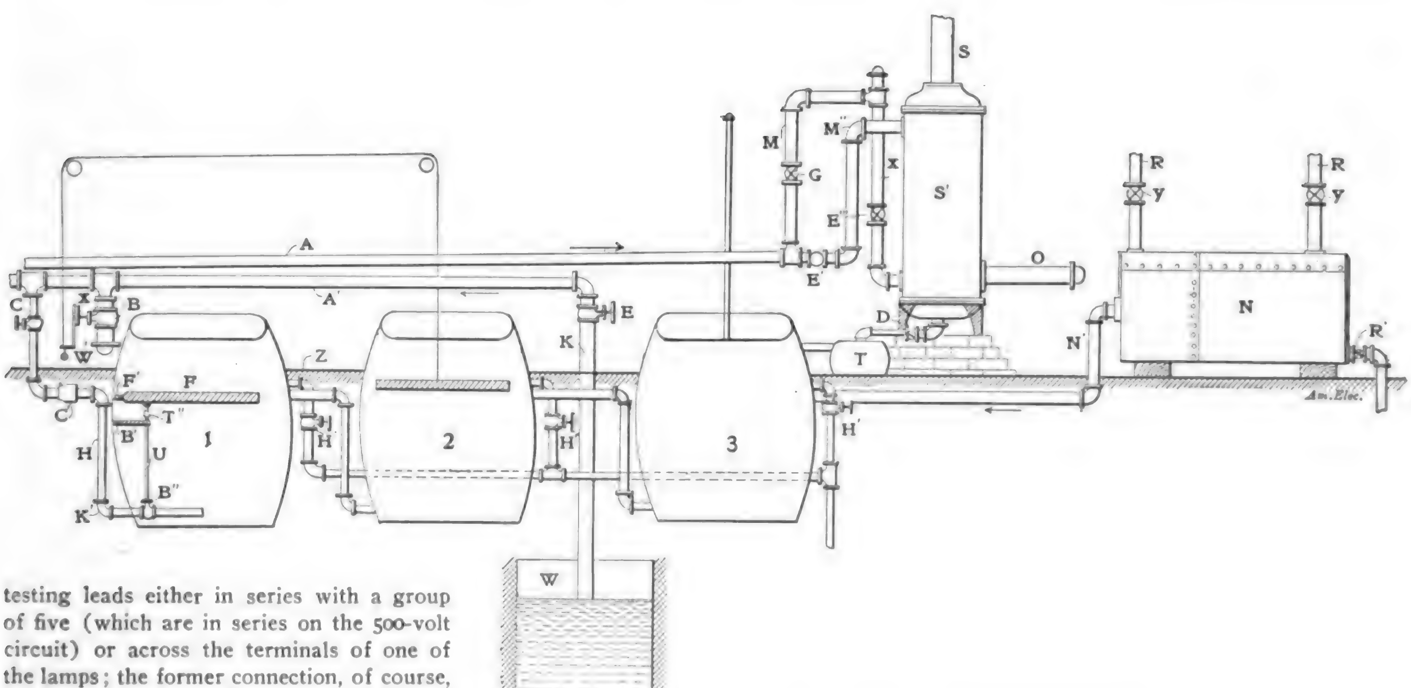


FIG. 1.—EXTRACTING OIL FROM EXHAUST STEAM.

acted as a check valve and is shown at *B"*. The water enters the pipe under the valve and is discharged from the top. A check valve was placed in the suction pipe, *H*, at *c*, to prevent the water entering the barrel

when the city water was used for boiler feed. Water was taken from the well at times, but we did not get good results with this on account of the scale-forming property in it. The city water connection is shown at *B* and the floor line at *Z*. Pipes are connected just above the inlet to the barrels, and are also connected to a common blow-down or drain, as shown at *H'*; as fast as the oil accumulated on top of the water in the barrels it was blown off through this pipe. This kept the water in barrel No. 1 free from oil and perfectly safe to be returned to the boiler.

It is a well-known fact that where heating returns are returned to the boiler very little new water is added to that which is in circulation. It will be seen by tracing the piping that provision is made for this also in order to have the pump draw from the barrels. The city water must be shut off to relieve the check valve, *c'*, of the 40 pounds pressure caused by the tendency of the water to keep it closed. I overcame this obstacle by placing a float in barrel No. 2 and connecting a cord to it, which passed over two pulleys to a lever made fast to the stop valve in the city water main at *X*.

When the water accumulates in the barrels, as before explained, the float moves upward, allowing the weight, *W*, to move downward and close the valve, thus shutting off the water from the city supply. This relieved the check valve, *c*, of the weight on top of it and allowed it to open, and the atmospheric pressure forcing the the pump forming a vacuum on one side water out of the barrels into the pump cylinder.

In case the city water was not needed for any length of time to keep up the supply, the cord was disconnected from the lever and the valve, *X*, closed. It will be seen by the sketch that in a steam plant where all of the water is taken from a well or river that no float will be needed in barrel No. 2. But in any case where the water comes to the pump under pressure, a float or some other arrangement must be used to shut it off while the pump draws the water from the barrels.

The trap was placed between the heater and the barrel, as shown at *T*, and all condensation that accumulated in the bottom of the heater was also discharged into barrel No. 3. It will be seen that the water comes to the pump warm and is forced through pipe *A* to the heater at the top, passing through a coil and discharging at the bottom through the pipe *X* to the boiler.

The change resulted in a great saving in the amount of coal used thereafter and reduced the work of the fireman, for under the old conditions of the plant, where cold water was forced through the heater, it was impossible to keep up the steam pressure at times even by forcing the boiler. The pipe, *M*, is a by-pass, and in case the heater is out of order water is forced to the boiler by opening the valve, *G*, and closing valves *E"* and *E'*. The exhaust pipe is connected in like manner, but is not shown in the sketch. This change pleased the superintendent so well that he raised my salary.

Letters on Practical Subjects

Communications intended for publication in this department must be received at this office not later than the 15th of the month prior to the date of publication.

Mr. Lyons' Motor Trouble.

Referring to Mr. A. C. Lyons' trouble with a three-phase induction motor, which was described in the May number, I should think the trouble was in the compensator; probably in the joint where the taps from the mains connect to the movable arm of the oil switch, or to one finger not making contact. Humming would indicate that the motor was only receiving two instead of three phases. A. C. Towne.

Montreal, Can.

If every electrical part and all connections were in correct condition in the induction motor of Mr. A. C. Lyons, as they appeared to be, the trouble was loose caps of bearings. Had he tightened these he would have seen his motor running. When the caps are not screwed hard down when current is thrown on the stator of an induction motor, the stator draws up the rotor and holds it fast against the upper teeth. If Mr. Lyons wishes to try the experiment he has only to loosen the caps of the bearings of a good induction motor that is running in good order.

M. L. Schiaffino.

Guadalajara, Mexico.

Referring to the trouble Mr. A. C. Lyons had with an induction motor not starting, I would suggest a possible explanation of the trouble. At least I have seen three-phase motors act the same way, and their trouble was due to this cause. When current began to flow in the primary, the rotor was pulled over against the stator laminations, there being a very strong magnetic pull between the two. The reason for this might be a poorly centered rotor, so that the air-gap is not uniform, or the laminations may be loose on either stator or the rotor, or both. These would be drawn together when current was flowing and might spring back (probably would) when the current ceased; so that it would not be apparent on ordinary inspection of the motor when not excited. The rotor bearing must be very rigidly fixed relative to the field.

Schenectady, N. Y. Robt. E. Noyes.

Mr. Turner's Telephone Circuit.

I offer the enclosed diagram (Fig. 1) as a solution of Mr. Turner's problem in telephone signalling circuits published in this department of the May number. The signalling apparatus and polarized bells at each station are connected up separately

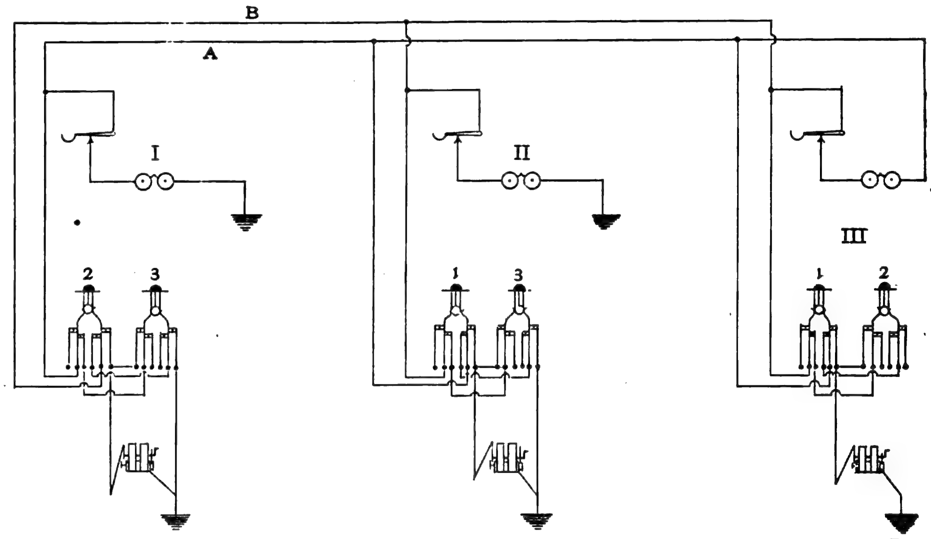


FIG. 1.—MR. BETHEL'S SOLUTION.

from the other apparatus, which is bridged across the line in the usual fashion and is therefore not shown in the diagram. My idea is to use standard push-button keys for signalling, the connections being clearly shown in the sketch. Station *I* has its bell connected between line-wire *A* and the ground; the bell at Station *II* is connected between line-wire *B* and the ground, while the one at Station *III* is bridged across the line as usual. Depressing push-button *2* at Station *I* puts the generator at that station between line-wire *B* and the ground, so that the generator current affects only the bell at Station *II*. Push-button *3* puts the generator across the line, so that it rings the bell at Station *III*. The connections at the other stations are correspondingly ar-

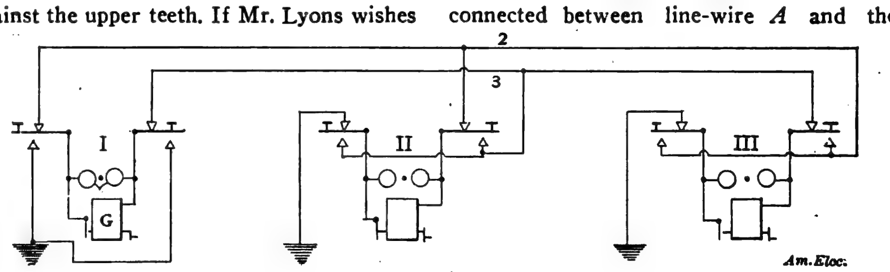


FIG. 2.—MR. BONE'S SOLUTION.

ranged; the button having a given number connects the generator to the bell at the station of the same number.

Washington, D. C. N. P. BETHEL.

The accompanying diagram (Fig. 2) is offered as a solution of Mr. Turner's problem. The talking circuits are the same at all stations and are bridged on the line in the usual manner. The ringing circuits are independent of the hook switches, and the two double-contact (two-way) push-buttons or ringing keys are used at each station. Double-throw, single-pole switches could be used, but trouble might be caused by leaving them in the wrong positions. The keys at each station connect the ringing circuit of that station with the ringing circuit of the stations of corresponding numbers. The ringing circuit at Station *I* is normally bridged across the line by the selective keys; that at Station *II* is normally connected between line-wire *2* and the ground, while that at Station *III* is normally connected between wire *3* and the ground. Consequently, any generator connected across the line will ring the bell at Station *I*, one connected between wire *2* and the ground will ring the bell at Station *II*, and one connected between wire *3* and the ground will ring the bell at Station *III*. If the generator at Station *I* be operated while it is across the line it will probably ring the bells at Stations *II* and *III* as well as that at Station *I*, because those two are in series across the line through their ground connections. If any receiver is off the hook when a signal is given, all the bells will ring, because the line-wires are then bridged by the talking circuit. If both keys are depressed simultaneously at any station, the signalling apparatus at that station will be short-circuited. Any station could probably call the other two simultaneously by ringing without depressing either key; but a button could be provided for disconnecting the home bell, and the other two could then be rung strongly in series.

Reading, Mich. FRANK W. BONE.

The accompanying diagram (Fig. 3) is one solution of Mr. Turner's problem. The talking apparatus at each station is bridged across the line in the usual manner. The ringing apparatus is separated from the hook switches and connected as shown in the diagram: The generator at each station is connected by means of a two-way, single-pole switch to the ringing circuit of either one or the other of the two stations; these switches are to be left open when not signalling.

Colton, Cal. L. P. BRODE.

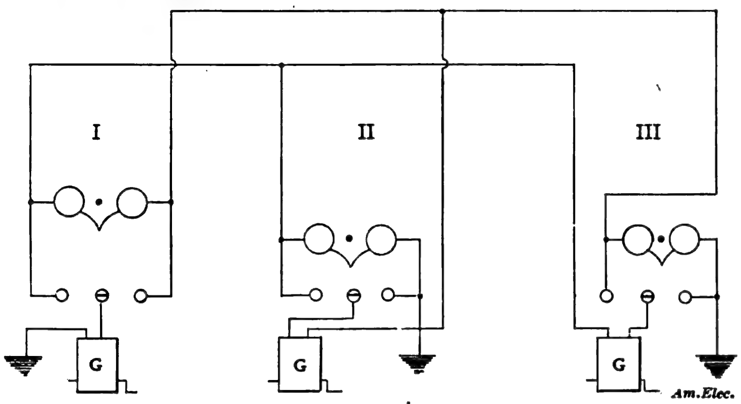


FIG. 3.—MR. BRODE'S SOLUTION.

The simplest solution of Mr. Turner's problem is probably that shown by the enclosed diagram (Fig. 4). At Stations *I* and *II* two double-contact push-buttons are used to select the station to be called. The talking circuit at each of these stations is bridged across the line normally, but one lead passes through the left-hand push-button. The ringing circuit is divorced from the remainder of the set, excepting the hook switch. By tracing the circuits it will be found that the ringing circuit at Station *I* is normally connected between line-wire *1* and the ground; that at Station *II* is normally connected between wire *2* and the ground, while that at Station *III* is divided normally, the bell being bridged across the line through the hook switch as usual and the generator being grounded at one terminal and connected to a two-way switch, *S*, at the other; this switch connects it to either one or the other of the line-wires, but never to both simultaneously. Depressing button *ii* at Station *I* puts the ringing circuit of that station between the line-wire *2* and the ground, so that the generator can ring the bell at Station *II;* depressing button *i* at Station *II* puts that ringing circuit between wire *1* and the ground, ready to ring the bell at Station *I;* depressing the button *iii* at either Station *I* or *II* puts the generator at that station across the line, ready to ring the bell at Station *III*. The switch at Station *III* is normally open, as shown; turning it to button *i* puts the generator in parallel with the bell at Station *I*, and turning it to button *ii* puts the generator in parallel with the bell at Station *II*. If desired, an auxiliary bell could, of course, be connected in parallel with the generator at Station III so as to provide an indication of the performance of the generator; as the circuits are shown, no ring is heard at that station when one of the others is called up. The object in separating the generator from the receiving bell and using a different switching device is to avoid having the generator normally across the line, in which relation it would ring both of the other bells simultaneously if the handle were turned without throwing the selective switch.

Brooklyn, N. Y. GEO. W. MALCOLM.

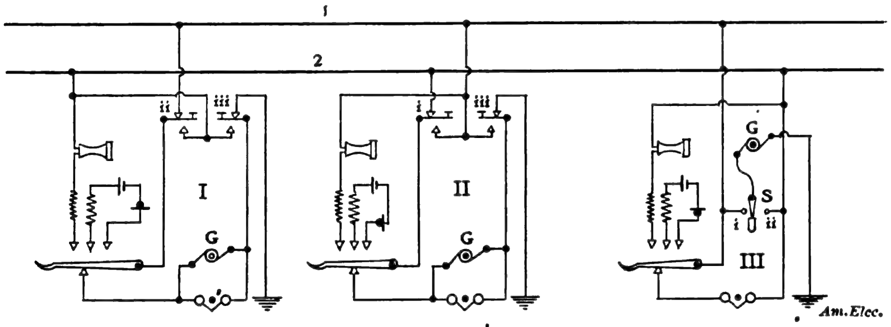


FIG. 4.—MR. MALCOLM'S SOLUTION.

The accompanying diagram (Fig. 5) is submitted as a solution of Mr. Turner's problem published in the May issue. Three-point button switches are used at each station for selective ringing, but knife-blade switches could be used if desired. To call Station *B* from Station *A*, the switch *R* is thrown to the right and the generator

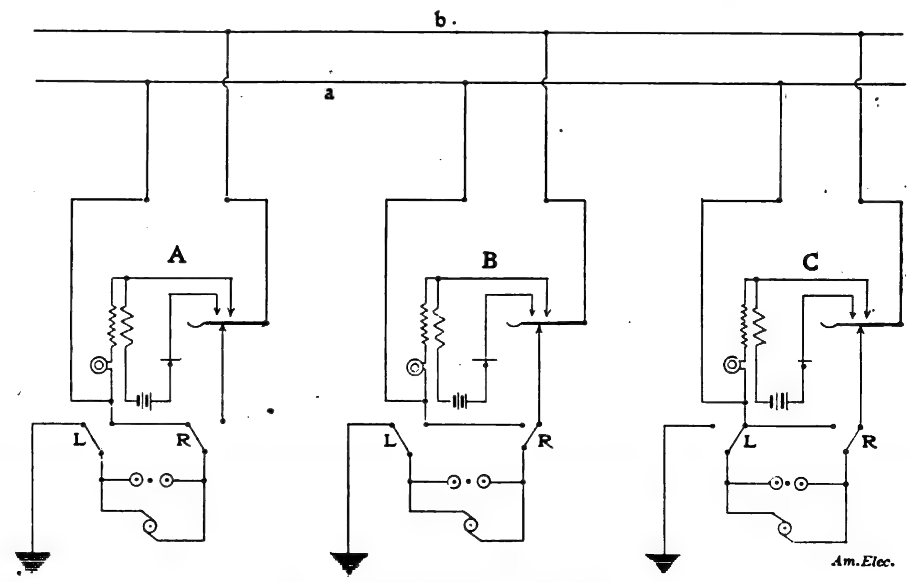


FIG. 5.—MR. SHADBOLT'S SOLUTION.

operated; to call Station *C*, both switches are thrown to the right. At Station *B*, to call Station *A*, the switch *R* is thrown to the left; to call Station *C*, the switch *L* is thrown to the right. At Station *C*, to call *A*, the switches are both thrown to the left, and to call *B*, the switch *L* alone is thrown to the left. All of the switches must normally set as shown in the diagram.

Osage, Minn. W. H. Shadbolt.

Mr. Lincoln's Storage Battery Connections.

The arrangement shown by the accompanying sketch (Fig. 1) fulfills the requirements of Mr. Lincoln's problem published in the May number. The double-pole, double-throw switch *C* puts the whole equipment on either of the supply circuits, *A* or *B*, or cuts it off both for charging the small cells by means of the large ones. With this switch closed in either direction, the cells *P* may be charged through the regulating resistance *R* from one of the supply circuits by throwing the switches *D* and *E* downward, and with *D* closed downward and *E* closed upward, all of the batteries are connected in series to one of the supply circuits. To charge the cells *P* from the cells *X*, *Y* and *Z*, the switch *C* is opened and the other two closed upward. The switches *G* and *H* determine which of the cells *X*, *Y*, *Z* are active.

Washington, D. C. N. P. Bethel.

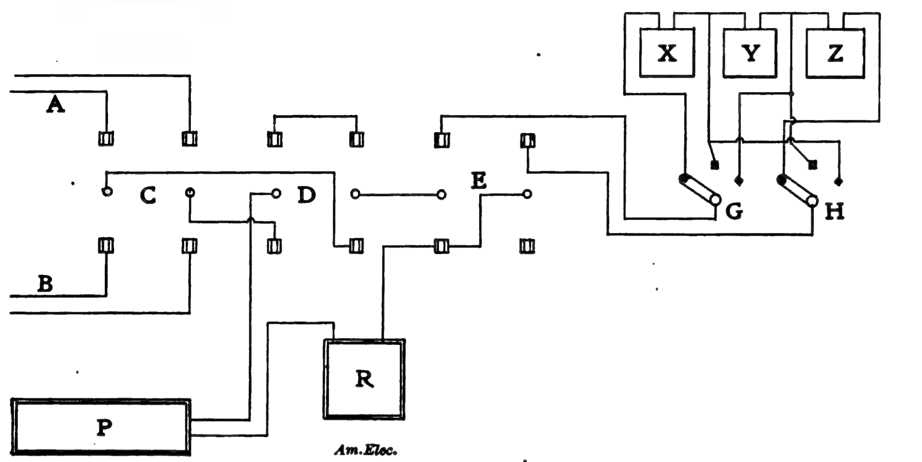


FIG. 1.—MR. BETHEL'S SOLUTION.

Enclosed is a diagram (Fig. 2) which meets the conditions of Mr. Lincoln's problem. With the double-throw switch *D* thrown downward, the switch *C* connects the equipment to either supply circuit, *A* or *B*. Under these conditions, the switches *E*, *F*, *G* determine whether the portable cells *P* shall be put in circuit alone or in series with one or more of the large cells *X*, *Y*, *Z*. By closing the switch *D* upward, the portable cells may be charged by the large cells.

Newark, N. J. F. S. Brewer.

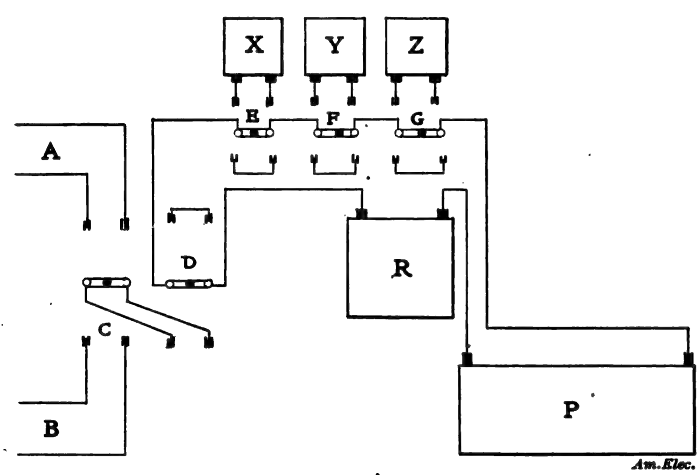


FIG. 2.—MR. BREWER'S SOLUTION.

I offer the enclosed sketch (Fig. 3) as a solution of Mr. Lincoln's problem in battery connections. The double-throw, single-pole switches *E*, *F*, *G*, determine which of the cells *X*, *Y*, *Z*, are actively in circuit; the switch *D* connects this group of cells *X* to the portable cells for charging the latter or to the main switch *C* in series with the portable cells, for charging both of the batteries from one of the supply circuits. The double-pole, double-throw switch *C* connects the equipment to one or the other of the supply circuits, *A* or *B*.

Colton, Cal. L. P. Brode.

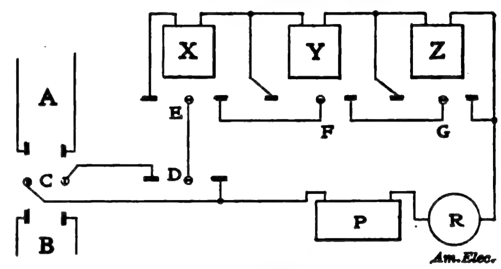


FIG. 3.—MR. BRODE'S SOLUTION.

For solving Mr. Lincoln's problem in storage battery connections I would suggest using one double-pole, double-throw and four single-pole, double-throw switches connected as shown by the enclosed sketch (Fig. 4). The double-pole switch *1* connects the entire outfit to either of the supply circuits or disconnects it from both; the switches *2*, *3*, *4* vary the number of large cells in circuit with the portable battery, and the switch *5* puts the two sets of batteries to the switch *1* in series or cuts them off and connects them together for charging the portable cells from the large ones. If it should be desired to charge the

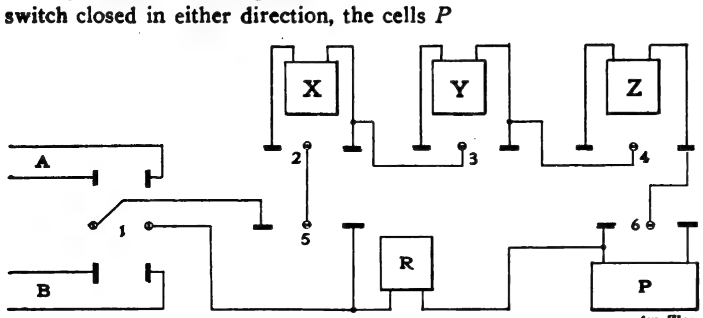


FIG. 4.—MR. FISKE'S SOLUTION.

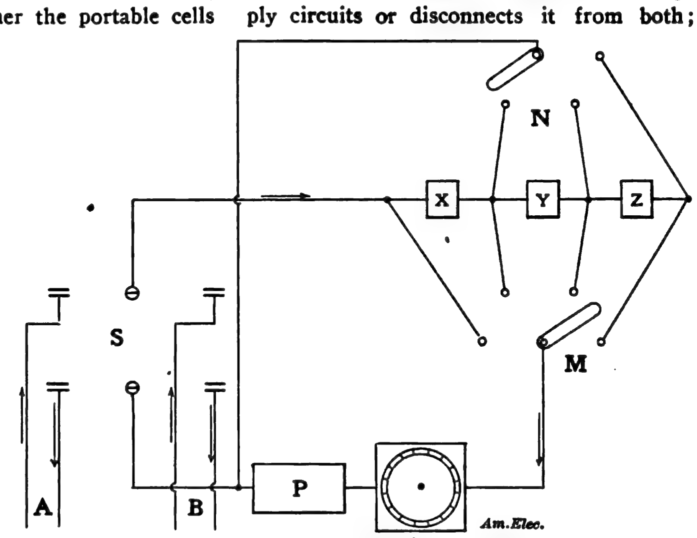


FIG. 5.—MR. JOHNSON'S SOLUTION.

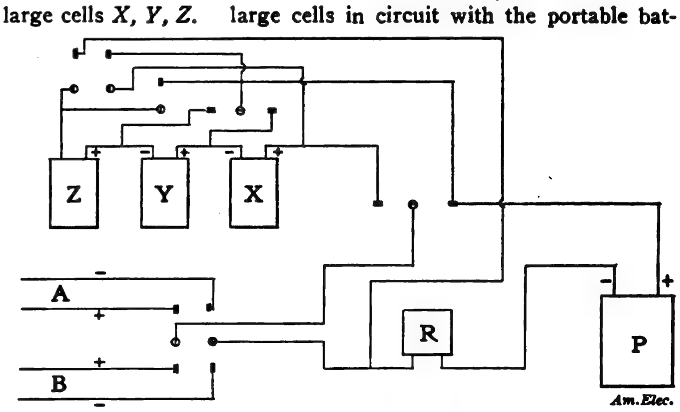


FIG. 6.—MR. LINCOLN'S SOLUTION.

large cells from one of the supply circuits separately from the portable cells, a single-pole, double-throw switch could be connected, as shown at *6*, but this is unnecessary for the fulfillment of the requirements stated in the problem.

Kingston, R. I. HERBERT A. FISKE.

I suggest the accompanying diagram as

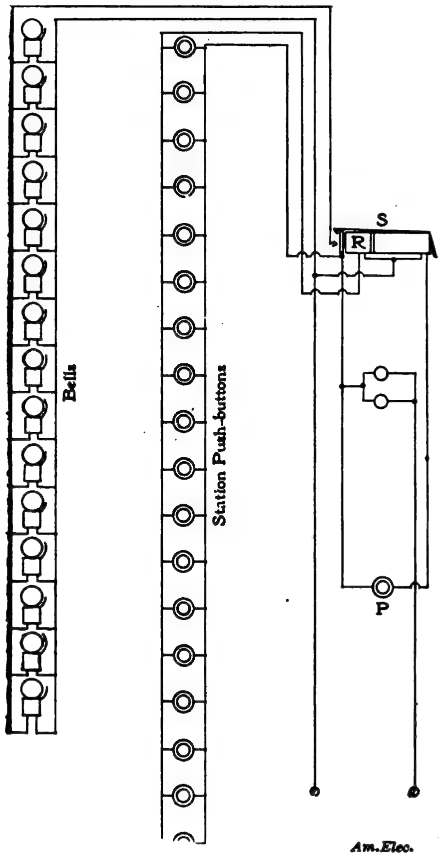


FIG. 1.—MR. BETHEL'S SOLUTION.

a solution of Mr. Lincoln's problem in battery connections. There are four single-pole, double-throw switches and one double-pole, double-throw switch; the latter (*1*) is used to

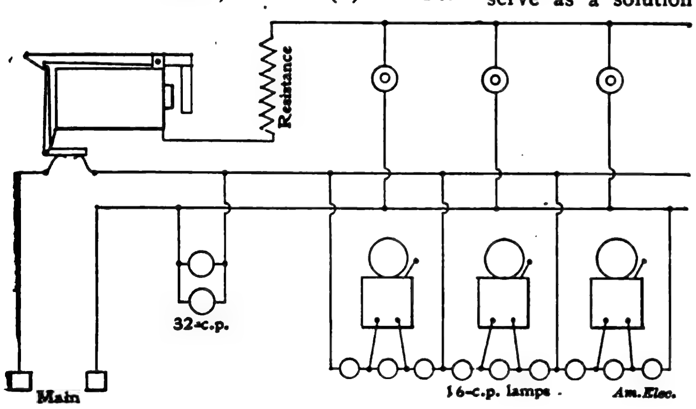


FIG. 3.—MR. MERRILL'S SOLUTION.

connect the local circuits to either of the supply circuits for charging. The switch *5* is used to cut the large cells in or out of circuit with the portable battery; the others, *2*, *3*, *4*, serve to put any one or two or all three of the large cells in the local circuit. By leaving the switch *1* open, closing *5* to the right and properly manipulating the other three switches and the rheostat, the portable battery can be charged from the large cells.

Ironwood, Mich. LOUIS J. GORILLA.

[Mr. Gorilla's diagram being identical with that of Mr. Fiske, the one engraving has been used to illustrate both solutions.—EDITOR.]

The enclosed sketch (Fig. 5) is submitted as a solution of Mr. Lincoln's problem. A double-pole, double-throw switch, *S*, is used to connect the battery circuit to either of the supply circuits, *A* and *B*, or to disconnect from both. With *S* open, the large cells can be connected to the portable battery for charging the latter, in any desired combination, by manipulating the three-point switch *N* and the four-way switch *M*. With *S* closed to one of the supply circuits, the two batteries may be charged in series by leaving *N* open and setting *M* on the extreme right-hand point. If it be desired to charge the portable cells from one of the supply circuits, this may be done by setting *M* on the extreme left-hand point, leaving *N* open, and closing *S* to the desired supply circuit.

Detroit, Mich. FRANK JOHNSON.

[Mr. Lincoln's solution of his problem is shown by Fig. 6.—EDITOR.]

Mr. Petry's Wiring Problem.

The accompanying diagram (Fig. 1) is one solution of Mr. Petry's problem published in the May number. The diagram is practically self-explanatory; the push-button *P* throws the shutter *S*, and depressing any one of the station buttons restores it by means of the auxiliary coil *R*. The two lamps are indicated at *L*.

Washington, D. C. N. P. BETHEL.

Assuming that Mr. Petry intended that his shutter should be set by hand and released electrically, the enclosed diagram will serve as a solution of his problem. The 32-c.p. lamps are shown connected in series, it being assumed that low-resistance bells and shutter winding will be preferred, but they could, of course, be put in parallel with each other if the other resistances in the circuit were too high. Only two bells and push-buttons are shown, but it is a simple matter to add the requisite number of each in parallel with these two.

Louisville, Ky. JAMES B. DILLON.

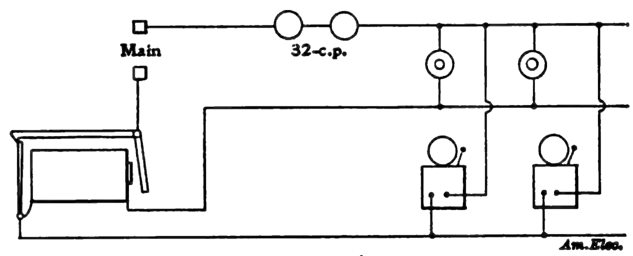


FIG. 2.—MR. DILLON'S SOLUTION.

I offer the enclosed diagram in solution of Mr. Petry's problem. The 32-c.p. lamps are used as pilots and the bells are connected each in shunt to one of a series of three 16-c.p. lamps in order to obtain the

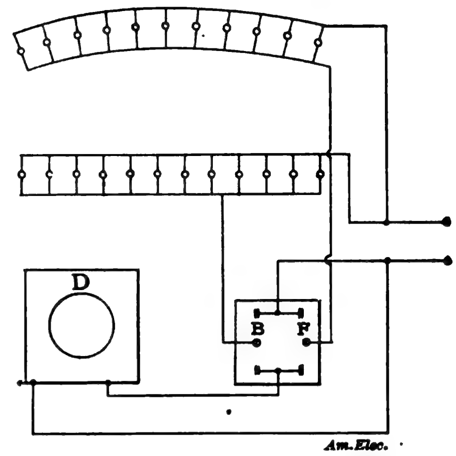


FIG. 2.—MR. GORILLA'S SOLUTION.

low e.m.f. necessary to operate them. The remainder of the diagram is self-explanatory. It might be advisable to use larger lamps than 16 candle-power for reducing the voltage to the bells, unless the bell magnets are wound with smaller wire than ordinarily. I have used this method of supplying bells from electric lighting circuits with complete success, but always had to use high-resistance bells.

Wilmington, Del. WM. MERRILL.

Mr. Converse's Stage Lighting.

Mr. Converse's problem in stage lighting connections is solved by the use of two double-pole, double-throw switches connected to the footlights, border lights and dimmer, as shown by the enclosed sketch (Fig. 1). The switch *B* connects the border lights directly to the supply circuit when thrown upward, and to the circuit in series with the dimmer when closed downward. The switch *F* controls the footlights in exactly the same manner.

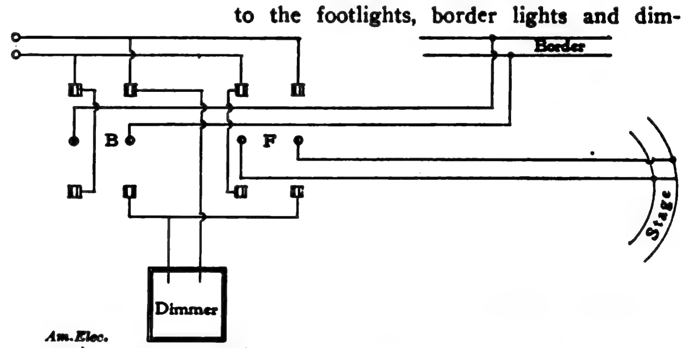


FIG. 1.—MR. BETHEL'S SOLUTION TO MR. CONVERSE'S PROBLEM.

Washington, D. C. N. P. BETHEL.

[The same solution was supplied by Messrs. F. S. Brewer, Newark, N. J.; W. A. Loveland, Philadelphia, Pa.; J. W J. Manning, South Boston, Mass., and Chas. B. Wilson, Chicago.—EDITOR.]

Referring to Mr. Converse's problem, I would suggest the solution shown by the accompanying sketch (Fig. 2). Two single-pole, double-throw switches, *B* and *F*, are used; to burn the border lights brightly, the switch *B* is closed upward, and to dim the border lights it is closed downward. The switch *F* controls the footlights the same way. Obviously both groups may be dimmed simultaneously by throwing both switches downward.

Ironwood, Mich. LOUIS J. GORILLA.

[The same solution was supplied by Messrs. E. S. Lincoln, Brookline, Mass.; Jack Maury, Rossville, Ill., and Geo. C. Ohlin, South Omaha, Neb. It agrees with the author's own solution of his problem.—EDITOR.]

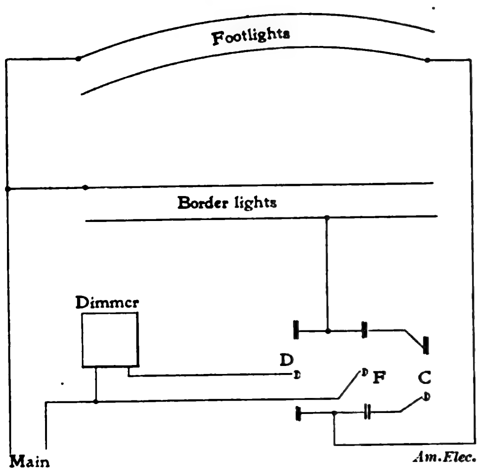


FIG. 3.—MR. BRODE'S SOLUTION.

To solve Mr. Converse's problem, I would suggest using two single-pole, single-throw switches connected as shown by the accompanying diagram (Fig. 3). With the switch *C* open, the switch *F* will put either of the groups of lamps directly on the supply circuit and the switch *D* will connect either of them through the dimmer; closing *C* couples the two groups together, so that they may be put directly on the circuit or through the dimmer simultaneously.

Colton, Cal. L. P. BRODE.

The agreement of switches shown by the enclosed sketch (Fig 4) is one solution of Mr. Converse's problem. Closing the switch *1* downward and *2* upward puts the border lights directly on the circuit; then changing *1* to the upper jaw puts them through the dimmer. Closing the switch *1* downward and *3* upward puts the footlights directly on the circuit, and shifting *1* upward puts them through the dimmer. With *1* closed downward and both of the others closed upward, all the lamps are directly on the circuit, and shifting *1* upward puts them through the dimmer together. By closing *2* and *3* downward the two groups are put in series to the switch *1*, which will connect them directly to the circuit or through the dimmer.

Kingston, R. I. HERBERT A. FISKE.

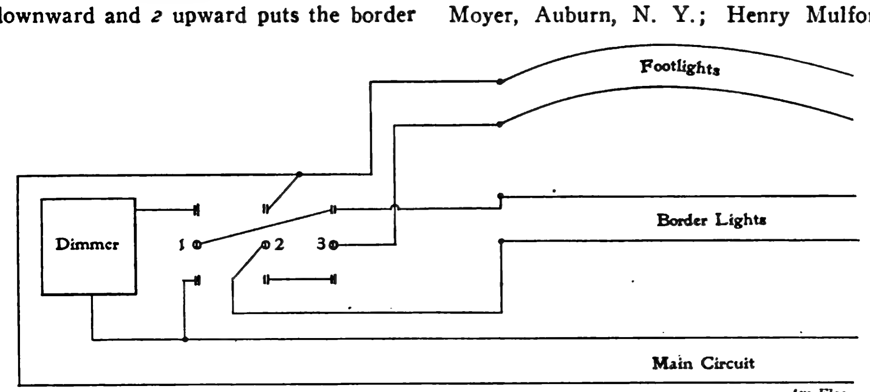


FIG. 4.—MR. FISKE'S SOLUTION.

Mr. Deighmiller's Meter Reading.

The reading of Mr. Deighmiller's meter dials published last month is 49,992; since the pointer of the 100's dial has not completed its revolution, the one of the 1,000's dial must lie between 9 and 0, and the hand on the 10,000's dial lies between 9 and 0 also, so that the hand of the 100,000's dial must lie between 4 and 5. The indication of the 10's hand is obvious.

Boston, Mass. DONALD BOWMAN.

I would read Mr. Dieghmiller's meter 49,992. When the 10's hand completes its revolution the 100's hand will go to 0, and the next two hands will do likewise; the 100,000's pointer then will be at 5, and the reading will then be 50,000. Until then, the indication must be one less on all the dials except the 10's, which plainly is at 2.

Louisville, Ky. JAMES B. DILLON.

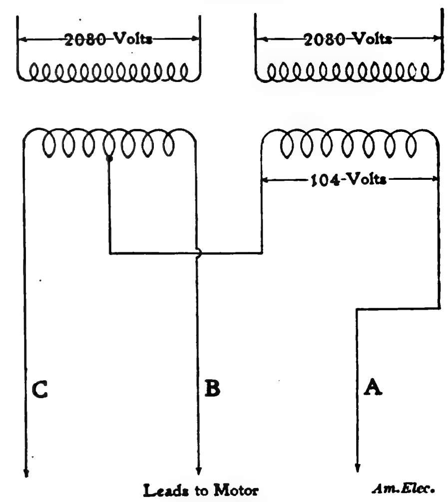
Referring to Mr. Deighmiller's tricky meter reading I should say that the reading is 49,992. The first dial (on the right) is evidently just beyond 2, so that the next pointer must be just beyond 9, but it has not yet reached 0. Consequently the next two pointers must be read 9, and the last one has not yet reached 5, so that it is to be read 4.

New York. JACOB GLOGAN.

The correct reading, but without any explanation, was also supplied by Messrs. F. S. Brewer, Newark, N. J.; G. F. Erfurth, Fort Smith, Ark.; Herbert A. Fiske, Kingston, R. I.; Jack Maury, Roseville, Ill.; Wilson A. McCown, Ladonia, Tex.; Miss Laura J. Moyer, Auburn, N. Y.; Henry Mulford, Patchogue, L. I.; Robert E. Noyes, Schenectady, N. Y.; A. P. Royal, Ellsworth, Me.; Gilbert G. Ryneas, Ambler, Pa., and Leon C. White, Brattleboro, Vt.—EDITOR.

A Transformer Trouble.

A customer on our system has a 110-volt three-phase induction motor supplied with current from transformers which are Scott-connected to get three phases from two, as



A TRANSFORMER TROUBLE.

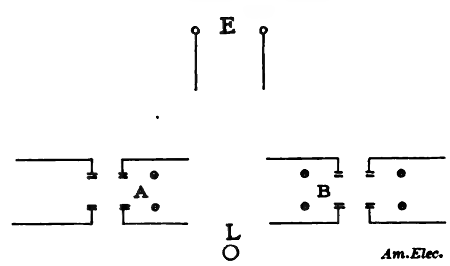
shown by the sketch herewith. It was desired to supply three 16-c.p. lamps from the same mains that supplied the motor, but when the connections were made the following difficulties developed: With one lamp connected across *A* and *B*, we got 104 volts, but with three connected there, only 30 volts; the same results were obtained with connections to wires *A* and *C*, but across *B* and *C* we could get no voltage. It may be of interest to some readers of this journal to figure out what the trouble was. It was soon found and remedied.

RALPH RYDER.

New York.

Problem in Switch Connections.

The accompanying diagram represents an incandescent lamp, *L*, two single-throw, double-pole knife switches, *A* and *B*, and the main entering terminals, *E*. It is desired to make connections between these so that when either one of the switches is



PROBLEM IN SWITCH CONNECTIONS.

closed to light the lamps in its circuit (not shown in the diagram because they do not affect the problem) the lamp *L* will also light at full candle-power. Its voltage is the same as that of the supply circuit *E*. The two lamp circuits supplied through the switches *A* and *B* must not be cross-connected when the switches are open; they are necessarily connected, of course, with the switches closed.

GEO. W. MALCOLM.

Brooklyn, N. Y.

Questions and Answers

Inquiries not accompanied by the name and address of the inquirer, will not receive attention.

Will an induction motor start with a load if thrown directly on the line without any compensator? (2) What is the function of the compensator? W. H.

Yes, but it will take a terrific rush of current in doing it. (2) It reduces the voltage at the terminals of the motor and thereby reduces the initial rush of current.

Is it necessary to run all four wires of a two-phase line in the same conduit pipe, or can they be separated in two pipes? (2) If all four wires are in one pipe, what would be the effect of an unbalancing of the circuits? J. M. D.

It is preferable, but not absolutely necessary to put them all in one pipe. (2) There would be no effect on the inductive drop in the line.

How can a four-cycle single-cylinder gas engine be made to run steadily driving a dynamo? (2) Is not a two-cylinder engine better for that class of work? C. F. K.

By putting on a much heavier fly-wheel. (2) Yes, so far as uniformity of angular effort is concerned; excellent results are obtained, however, with two-cylinder, four-stroke-cycle engines.

Can a voltmeter be used instead of a galvanometer in a Wheatstone bridge? (2) What size of resistance wire should be used in a bridge for use at an e.m.f. of 10 to 20 volts? H. W. B.

Yes, but it will not be sufficiently sensitive for close work. (2) This depends on how much resistance you wish and what the divisions are to be. Probably No. 36 wire will answer in the high-resistance coils and No. 28 in the low-resistance section.

What class of apparatus is preferable for supplying an organ bellows with air, the apparatus being driven by an electric motor? (2) Can an air-pump equipped with an automatic regulator be used? F. V.

Both motor drive direct to the bellows "blow-shaft" and motor-driven centrifugal blowers of special design are used; the preference depends to a large extent on the location of the blowing apparatus with respect to the body of the church. (2) No.

How is the constant derived that is used in the formula for the temperature rise of an electrical conductor due to the current it carries? (2) How do the induction coils in the 40-volt central energy system of the Stromberg-Carlson Company differ from those used in the Hayes 24-volt system? L. P. M.

By experiment. (2) Induction coils at subscribers' stations are not used in the Haynes system; repeating coils are used at the exchange.

If a 60-cycle meter be put on a 90-cycle circuit, would its accuracy be affected? (2) Would an arc lamp consume more or less current if taken from a 60-cycle to a 90-cycle circuit? J. I. McG.

Probably; it depends on the type of meter. See answer to W. G. B. (2) A series-wound lamp would take the same current; a shunt-wound lamp would take less current and carry a longer arc and a differential lamp would probably do the same.

A series arc-lighting circuit equipped with an automatic reactive regulator when thrown on either "phase" of a two-phase alternating primary circuit causes a drop of 5 volts in that "phase;" why does this occur, and how can it be remedied? E. J. A.

The extra drop is due to the inductive character of the arc-lighting circuit; the regulation of an alternator is much poorer with a heavily inductive load than with a non-inductive one, or one of very high power factor.

What is wattless current? (2) What is the use of synchronous frequency changers? (3) What is a composite-wound alternator? E. M.

A current which is out of phase with its e.m.f. by one-quarter of a cycle. (2) To change the frequency of a supply circuit, so that apparatus requiring different frequencies may be supplied from a single generator or set of bus-bars. (3) An alternator having a compound-wound field and so arranged with its exciter as to regulate for changes in the power factor of the work circuit as well as changes in the load.

Please give instructions for making a magnet not over 2½ inches long to lift ½ pound a distance of ⅛ inch, with 5 volts at the terminals. H. W., Jr.

Use a stopped solenoid of the type described in the March number, with the following dimensions: plunger and core scant ⅜ inch diameter; yoke of strap iron ¼ by 1 inch cross-section; distance from top to bottom of yoke 2 inches; brass center tube ⅜-inch bore, full, and ½-inch outer diameter. Coil of No. 15 single cotton-covered magnet wire, wound to an external diameter of 2 inches.

What is probably the cause of a compound-wound generator dropping its voltage when the load is cut off? (2) What causes burnt spots on a commutator running with carbon brushes? D. E.

Its construction; that is exactly what it is intended to do. (2) Any one of several defects or a combination of some of them; the most common causes are loose leads in the commutator lugs, high mica between bars, inadequate connection between the brush and the stud, too light a tension at the brush springs, improper setting of the brushes, and poor design of the armature.

How can a 10-ampere arc-lighting dynamo of 30 lamps capacity be altered to maintain enclosed-arc lamps requiring 70 volts and 6.8 amperes? The 10-ampere lamps required 50 volts each. The armature is wound with No. 16, the field magnet with No. 9, and the regulator with No. 18. E. & C.

Rewind the armature with No. 18 wire, putting 1.4 times the present number of turns in each coil; rewind the field coils with 1.4 times the present number of turns, using No. 11 wire, and rewind the regulator with 1.4 times the present number of turns, using No. 20 wire. The speed will remain practically the same as before.

How can I ascertain the number of magnetic lines of force passing through the magnetic circuit of a motor? G. W.

Run the motor without any load and measure the speed accurately; multiply the revolutions per second by the total number of wires all around the armature core (number of commutator segments × turns per coil × 2); divide the voltage at the brushes by the product of speed and wires and multiply the result by 100,000,000. This is for a lap-wound armature; if the machine is multipolar and the winding is wave-connected, divide the final result by half the number of field magnet poles.

Would not the core of an induction coil be better if it were continuous, forming a closed magnetic circuit? (2) Where can I obtain flint glass and tinfoil suitable for making high-voltage condensers? (3) If two Leyden jars were charged from a high-voltage transformer and discharged through a discharger, should the latter be wound, and if so, how? C. O. W.

No; because it would not demagnetize quickly enough when the primary circuit is interrupted. (2) Probably from the Pittsburg Plate Glass Company and the Conley Foil Company, respectively, both of this city. (3) It is impossible to charge a condenser from a transformer and disconnect it with the charge in it.

Can a machine be used both as a dynamo and as a generator? W. J. G.

There is no difference between a dynamo and an electric generator.

What is the difference between the power factor of a single-phase system and that of a three-phase system of the same voltage and frequency, each supplying 5-hp. induction motors of the same make? (2) What is the chief objection to supplying lights and motors from the same single-phase alternator? G. H. L.

The power factor is determined by the combined power factor of all the motors and the line, not by the number of phases. Without knowing the joint power factor of the motors, the frequency of the supply, the length of the line and the distance between wires, your question cannot be answered. (2) The fluctuation of voltage due to the throwing on and off of the motors.

Does the frequency of the supply current affect the speed of an integrating watt-hour meter of the induction type? (2) If so, what would be the effect of changing from 133 cycles to 60? W. G. B.

To a slight extent, but the speed is not proportional to the frequency like that of an induction motor; changing the frequency changes the phase relations of the two magnetic fields and thereby affects the torque and speed somewhat—more than a negligible amount. (2) The exact effect cannot be predetermined without the full knowledge of the motor characteristics of the machine; its accuracy would be seriously impaired, and in order to avoid this, the compensating coils should be changed to correspond to the change in frequency.

Is it good practice to connect up distributed transformers to a common secondary main, the primary mains being 2200 volts and the secondary 110 volts; or is it better to have each transformer supply a separate main distributing current to a restricted locality? (2) With the transformers all in parallel at the secondary side and lightning arresters at the station, would there be any greater liability of crippling the system in a thunder storm than with the separate secondary mains? G. H. B.

It is not particularly bad practice to work the transformer secondaries all in parallel, if each one is properly fused in both primary and secondary, but this arrangement is open to the objection that the sudden disabling of one or two large transformers during the maximum load period will overload all the others on that secondary line. It is much preferable to let each transformer supply a separate secondary main, using transformers large enough to cover a considerable distribution area each. (2) Yes, slightly.

NEW WESTINGHOUSE CRANE MOTOR.

The Westinghouse Electric and Manufacturing Company has been closely identified with the problem of crane and hoisting service and has been actively engaged in the construction of electric crane machinery for more than a decade. The company's "Type K" motors are designed for the operation of cranes, hoists and similar apparatus and for intermittent service in which heavy starting torques and wide speed variation are required. Ten sizes are standard, including capacities from 2 to 40 horse-power. The frames are of the wholly enclosed form, so designed that the working parts may be exposed for inspection or adjustment without dismantling. If local conditions permit, the cover about the commutator may be removed and the motor operated open, with improved ventilation and increased capacity.

FIG. 1.—WESTINGHOUSE "TYPE K" CRANE MO TOR.

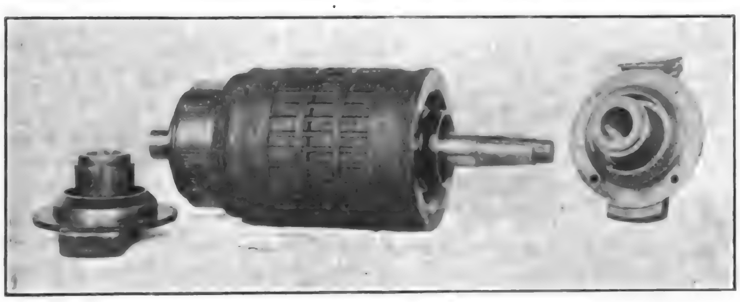


FIG. 2.—ARMATURE AND BEARING HOUSINGS.

FIG. 3.—WESTINGHOUSE "TYPE K" CRANE MOTOR.

Type K motors have four inwardly projecting poles, each of which is magnetized by a separate field coil. The motors are series wound and are designed for operation on direct current circuits of 220 and 500 volts. Since the current passes successively through armature and field winding, the torque of such a motor increases nearly as the square of the current up to the point of saturation of the iron. Governed by change of voltage at the motor terminals, the speed of the motor is carried through a wide range, the change in the resistance of the motor circuit being made by means of a controller.

The motor frames are of cast steel (except in the three smallest sizes, where they are cast iron). They are nearly square in section and require only a small amount of head-room on a crane, or floor space when used with hoists or similar apparatus. The frame is built in two parts, divided in a plane passing through the axis of the armature and at an angle of 34 degrees with the horizontal, an arrangement which allows the upper half of the field to be removed without disturbing the gears or shaft, and makes it easy to take out a pole piece and field coils, or to remove the armature. The lower half of the frame has four feet, with holes for bolting to the support. The lower casting has also two finished faces to which bearings for a countershaft may be bolted or which may be used for side mounting. The commutator end of the frame is connected to the poles by six ribs, any two of which may carry the brush holders. The opening around the commutator is entirely closed by a 3/32" sheet steel band, fastened by thumb screws.

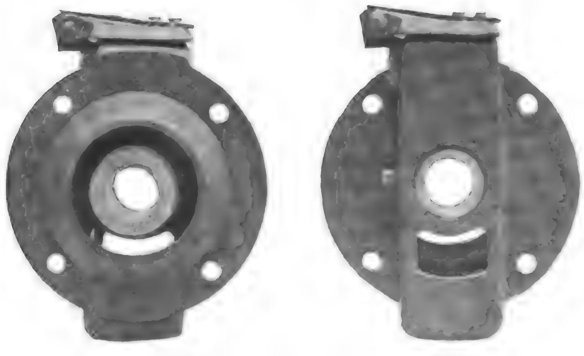


FIG. 4.—BEARINGS AND BEARING HOUSINGS, WESTINGHOUSE "TYPE K" CRANE MOTOR.

The four pole pieces are built up of soft steel punchings, riveted together between wrought iron end plates, and are secured to the frame by bolts which pass well into the punchings but leave the pole face smooth and unbroken. The coils of the larger motors are of copper strap and the terminals are insulated with asbestos ribbons. The coils are fitted to the pole pieces, protected at the ends by oiled duck and held in place by the spreading tips of the pole pieces. Shells lined with bronze or babbitt and mounted in housings which may be removed without separating the motor frame, constitute bearings. Great strength has been provided, with the wear distributed over a large surface, so that the bearings are suitable for the most severe service. Cast brass bearings are standard on all sizes up to and including the No. 4; on all frames above No. 4 babbitt bearings are used. Grease lubrication is employed in all except the larger sizes—the bearings of which are designed for lubrication by oil and waste. Drip cups are provided under the bearings for all motors.

The armature core is built up of soft steel punchings, carefully annealed. These punchings are, in all except the smallest sizes, assembled on a spider and held from turning by a steel key. The pinion end is provided with a bell-shaped flange, which forms a support and shield for the armature coils. Ducts between the punchings are provided

through which air, drawn in through openings in the spider, is forced out against field coils and core, maintaining a uniform temperature throughout all parts of the motor. The commutator is mounted on the armature web, allowing the shaft to be removed without disturbing the winding or connections. Covers of oiled duck adequately protect the end of the winding. Wiper rings or oil guards are provided at each end of the armature to protect the winding from oil.

The commutator is built up of bars of hard drawn copper, insulated by prepared mica, and mounted in the armature spider. The commutation is claimed to be good, in spite of the heavy rushes of current to which a motor of this class is subjected. The brush holders are of the sliding type. The individual holders may be independently adjusted. Tension is provided by means of a coiled spring which acts through a short brass strip, so that the spring responds immediately to any movement of the brush. The brush holder arms are secured by stud bolts to surfaces which are machined on the ribs of the frame, parallel to tangents at the points of contact with the brushes. Adjustment to compensate for wear of the commutator can be made by removing the iron washers which are placed under the insulating washers on the stud bolts.

With all but the two smaller sizes a shunt is connected to the tip of the spring, extended back over the spring and securely fastened to the brush holder, thus relieving the spring of the duty of carrying current. With every carbon brush ⅝" or more in thickness an additional sheet is provided connecting the carbon itself to the carbon holder.

Flexible leads are brought out through insulating bushings in the upper frame and are either connected to terminal blocks mounted on the top of the motor, or are arranged for direct connection to the controller lines.

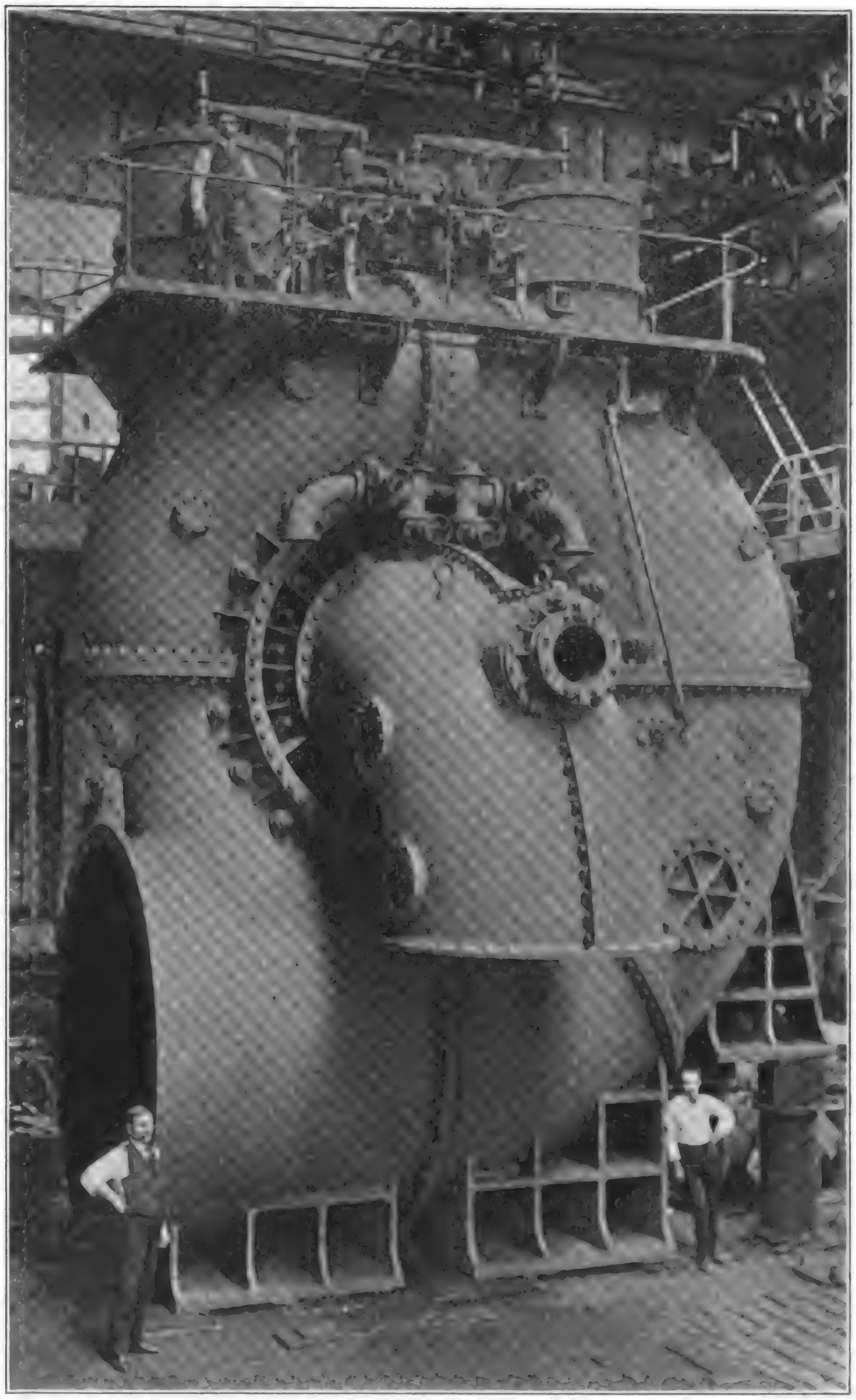
MAMMOTH WATER TURBINE

What is in all probability the largest water turbine ever built is now being installed in the power plant of the Shawinigan Water & Power Company, at Shawinigan Falls, on the St. Maurice River, Canada, by the I. P. Morris Company, of Philadelphia, Pa. The turbine has a capacity of 10,500 horse-power and its huge proportions are well shown in the accompanying engraving. The machine is 30 feet from base to top, 22 feet wide over all, and 27 feet from center to center of the two shaft bearings. Its total weight is in the neighborhood of 182 tons. The shaft, which is of forged steel, is solid and weighs 10 tons. It is 32 feet 3½ inches long, 22 inches in diameter at the center and tapers to 16 inches on the generator side and 10 inches in diameter on the other side. The runner of the wheel is of bronze and weighs 5 tons.

The quantity of water necessary to operate the turbine when under full load is enormous, no less than 400,000 gallons passing through per minute. This amount of water represents a river 100 feet wide, 9 feet deep and flowing at the rate of 60 feet per minute.

The turbine is of the horizontal-shaft, inflow-axial type, with spiral casing and a draft tube on each side, through which the water discharges outward from the center. The water enters the turbine through the intake 10½ feet in diameter, at the bottom of the turbine. It flows around and fills the outer spiral tube and then passes in radially through an annular set of distributor vanes and then through the wheel, and, diverging, finally discharges right and left through two large draft bends one on either side, of which one is shown in the engraving. Just outside these bends are situated the bearings of the shaft on separate pedestals not shown. What appears in the view is simply one of the two stuffing boxes through which the shaft (not shown) passes.

It will be noticed that although the diameter of the intake is 10½ feet at the bottom, the sectional area gradually diminishes as the water passes around the tube, the diminution being proportionate to the amount of water that flows through the wheel as its circumference is traversed. The two cylinders on top of the turbine contain the pistons which, operated by hydraulic pressure under the control of the governor, move the set of distributor vanes which regulate the supply of water to the runner for various



10,500-H. P. WATER TURBINE FOR SHAWINIGAN FALLS.

loads. The vanes, twenty-four in number, are hollow castings of bronze with a projected area of about 20 × 24 inches and have a small angular range of motion about steel pins passing through them and secured to the casting upon either side. They are connected by links to two large annular rings, one on either side, which move on ball bearings. Each ring is in turn connected by a rod to each of the two pistons, whose movement thus controls the angular position of the distributor vanes.

Some idea of the great force required to move these distributor vanes against the pressure of the water may be obtained from the manufacturer's statement that each of the pistons above was designed to exert a maximum pull of 100,000 pounds. The amount of power required to govern a turbine unit of this gigantic size is so great that the usual types of governors, hand-gear mechanism and controlling levers could not be used. The arrangement of powerful hydraulic engines and controlling devices adopted to meet this case is of original design and possesses many novel features.

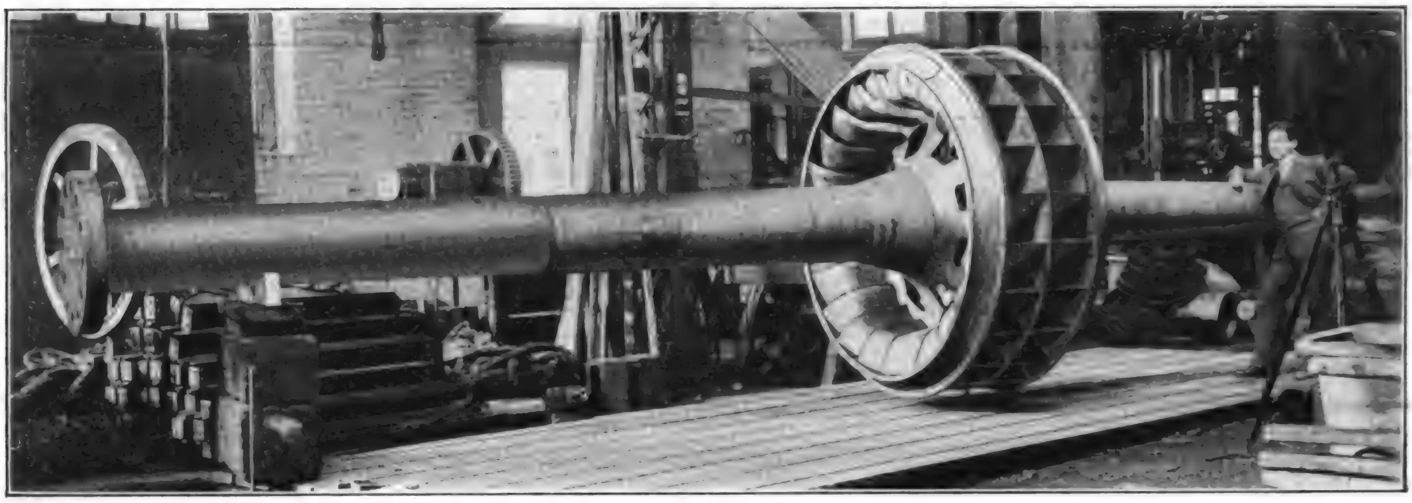


FIG. 2.—RUNNER AND SHAFT OF WATER TURBINE.

THE WILKINSON STOKER.

In the automatic stoker illustrated herewith, crushed or slack coal is fed into the hopper and mechanically forced down an easy incline under a kindling arch. It passes thence through various zones of heat and combustion, until it rests on the ash table, where final combustion takes place before it falls onto the ash slide. The incline is provided by heavy hollow grate bars having an alternate forward motion of about ¾ in. to 1 in. The surface of the bars is stepped, and

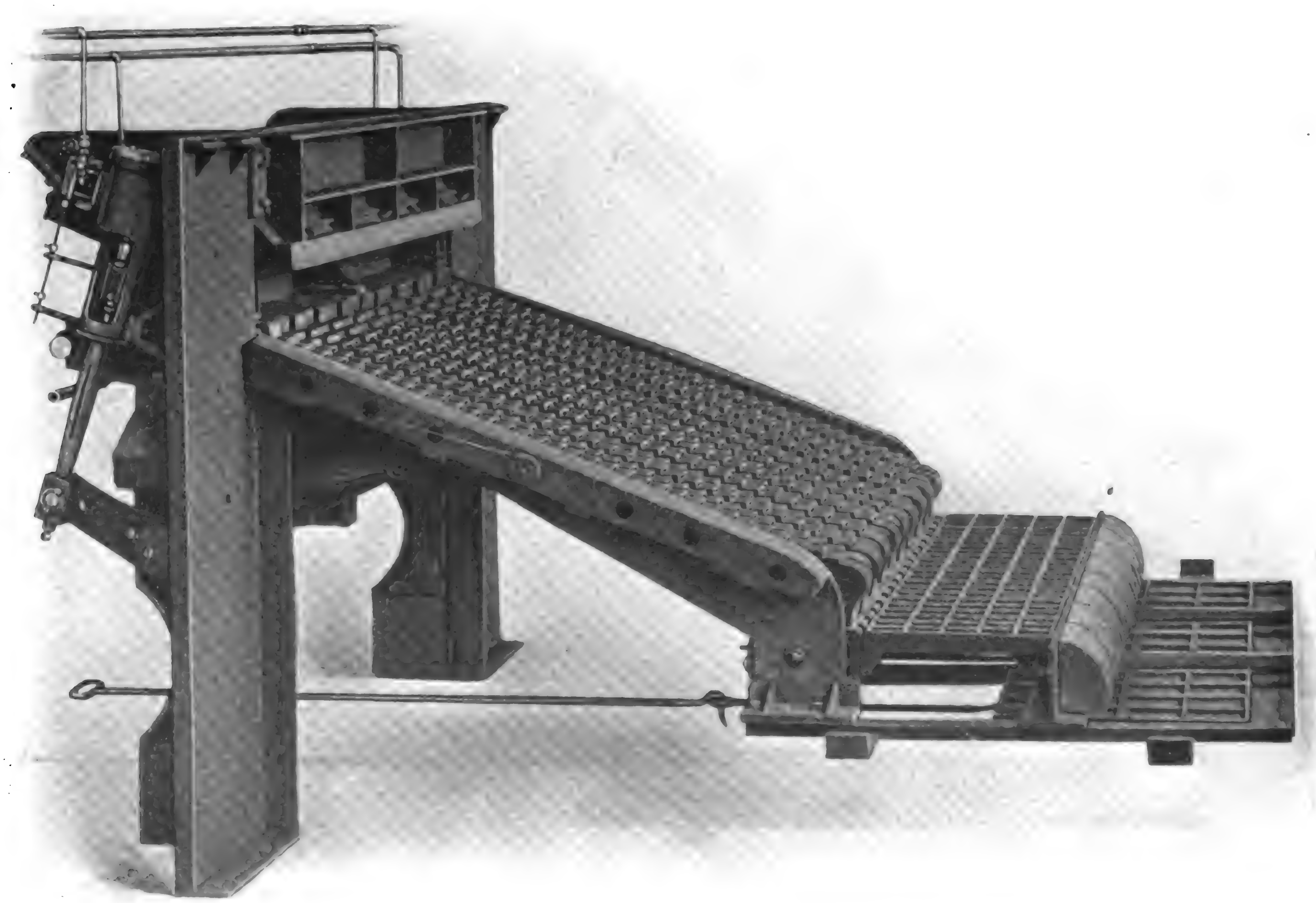


FIG. 1.—WILKINSON AUTOMATIC STOKER.

an alternate up and down and forward motion of one grate passing the other is provided. Introduced into the end of each hollow grate bar is a small steam jet, and this steam with the air which it sucks passes into the fire through openings in the rises of the steps mentioned.

The constant sawing action of the grate bars causes the fuel to travel forward and downward accompanied by steam and air. The combustion secured is said to be highly gaseous. The steam jet is automatically regulated in proportion to the boiler loads and requirements, the action being intense when the boiler is under a heavy load. The chief purpose of the steam jets is to preserve the grate bars from destruction. They also secure, it is claimed, a gaseous furnace combustion, disintegration of clinkers, and enable the use of grate bars set close together and avoid the waste of fine fuel.

The hopper, inclined hollow grates, ash table, ash slide, motor and driving mechanism are all shown in the illustration. The simplicity of the mechanism is evident. The stoker is driven by two small hydraulic motors, water to drive which is furnished by a small pump and tank located conveniently in the boiler room. The water is used over and over again. The power required is said to vary from ½ to 1½ per cent. Repairs may be made while the stoker is under fire by simply pushing the fire over the bar to be repaired to one side, stopping the stoker for a few minutes to unloose a pin under the stoker, when the injured bar can be taken out.

The mechanism of the stoker is illustrated so graphically in Fig. 2 that an extended explanation seems unnecessary. The fire-brick arch is furnished with the stoker. Coal having been placed in the hopper passes under the drop plate, and then down the grates, beginning to ignite and coke at a

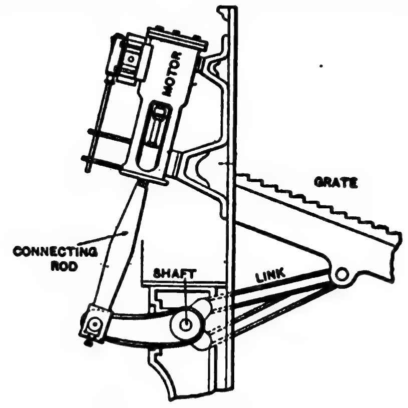


FIG. 3.—DRIVING MOTOR.

point A. A higher zone of combustion is reached at N, while at C a zone of practically white heat is said to be found when a heavy load is being carried. The partly burned out ashes land at D, where they give off their final heat, thence falling on the ash slides at E, whence they are removed by pulling out the ash slides.

The grate bar, a small section of which is given, weighs from 160 to 210 pounds according to the size of stoker, the length of bar being proportioned to the grate surface required. The stoker is adapted for slack, buckwheat and pea anthracite coals or bituminous slack. Regarding the excessive use of steam in the jets, the maker claims to have tested the stoker thoroughly and that with a steam jet the evaporation was 10.15 lbs. of water per pound of coal burned, while with a blower the evaporation was 9.22 lbs. These results were obtained while running the boiler 57 per cent. above its rating.

The grate bars are very heavy and in the rise of each step is an opening about ⅜ by 2½ ins. The surface of the grate exposed to the fire is said to be made of special iron suitable for high temperatures. Operated with ordinary intelligence the maker maintains that the cost of repairs should not exceed ½ of one per cent. of cost of investment per year. The stoker is built by the Wilkinson Manufacturing Company of Bridgeport, Penn.

INTEGRATING WATT-HOUR METER WITH PREPAYMENT ATTACHMENT.

The Fort Wayne Electric Works of Fort Wayne, Ind., have brought out a new single-phase integrating watt-hour meter, which, while intended primarily as a prepayment meter, may, by the substitution of a different base and case, be used as an ordinary induction watt-hour meter. All line connections are made inside a sealed terminal box on top of the meter to binding posts protected from accidental short-circuits. A four-dial register is provided which indicates the kilowatt-hours directly, no constant being necessary.

The Type-W meters are designed for 110 and 220-volt two-wire and for 220-volt three-wire circuits. The meter is made for four different ampere capacities: *i. e.*, 5, 10, 20 and 40, without transformers. The meter is said to be reasonably reliable and accurate in operation.

The prepayment attachment consists of three main pieces, the operating device, the meter case and the money box. These three pieces replace the case of the ordinary meter and are mounted on the prepayment base. The coin is placed in a slot in the hollow stem behind the knob projecting from the device where it fits into a slot in a stud within the stem. As the knob is turned to the right the coin is locked in as a key which turns the stud and operates the mechanism within the device, placing the coin to the credit of the consumer as shown by a figure above the knob. The knob, once started with a coin

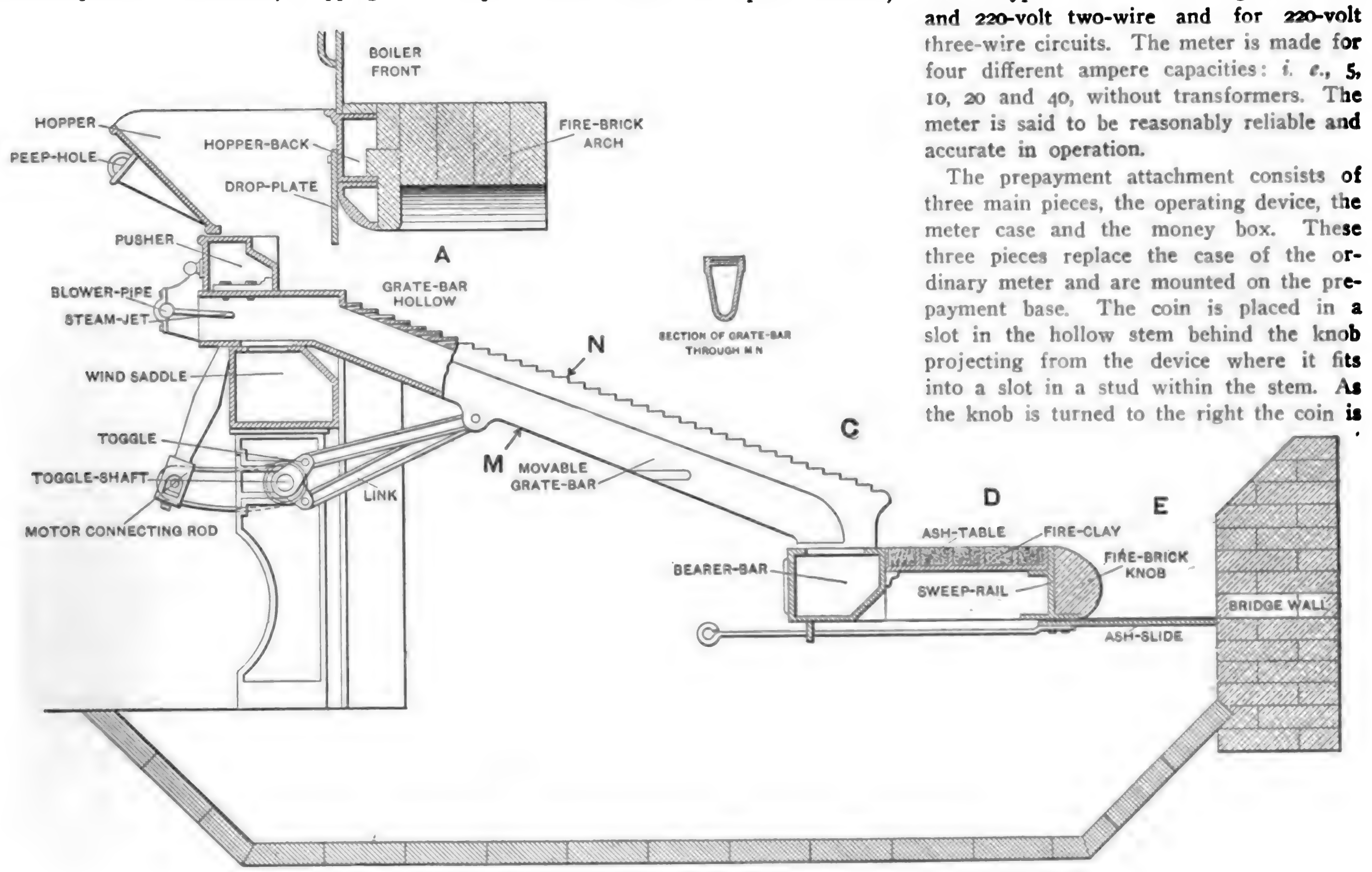


FIG. 2.—DETAILS OF WILKINSON AUTOMATIC STOKER.

locked in, cannot be reversed, but must be given a half turn to release the coin which falls through a tube to the money box below. The coin is locked in as soon as the knob is moved and cannot be abstracted except by unlocking the money box.

The actuating force which operates the device is in a large flat coil spring inside the barrel on the front end of which are the credit figures. The spring has many turns and as the operation of the device never equals one whole turn the spring always exerts a practically constant force.

The rear end of the spring barrel is covered by a disc having an internal and external gear on its rim. The external gear is acted on by the escapement gear in mesh with the registering mechanism of the meter. The internal gear is in mesh with an intermediate gear mounted on the spring barrel and meshing with a pinion on the stud within the knob stem. The function of this combination of gears is to render the operation of the escapement independent of the operation of the credit knob in its effect on the credit indicator. This permits the device to credit and debit simultaneously if the insertion of a coin should happen to coincide with the release of the escapement. The simultaneous credit and debit would leave the figure in the credit window unchanged. In the common operation of the device this condition rarely appears. The insertion of a coin usually occurs when the escapement is locked.

Inserting a coin and turning the knob rotates the intermediate gear and rolls it around on the internal gear of the stationary double-gear disc, carrying forward with it the spring barrel and credit figures. This increases the value of the figures, one for every coin inserted and shows the amount to the credit of the consumer. The debit operation takes place when the escapement is released by the meter register. Then the intermediate gear rolls in the opposite direction around the stationary pinion actuated by the coil spring and turns the credit figures back one place.

If the device is both debiting and crediting, the intermediate gear simply rotates on its axis and since both the pinion and the double-geared disc are rolling on it in opposite directions at equal rates, the position of the credit figures is the same after the operation as before. The capacity of the prepayment device is 20 coins. The coin box has a capacity of about 100 dimes.

When energy to the extent of the credit is consumed, the last escapement opens a four-point switch in the back of the prepayment box and disconnects the meter from the circuit. The switch will remain open until another coin is inserted; when turning the knob closes the switch and credits the coin.

The money box with coin tube is locked to a stud on the bottom of the meter case by an internal lock operated by a small key inserted in a slot. The box can be emptied of coins only by unlocking and removing.

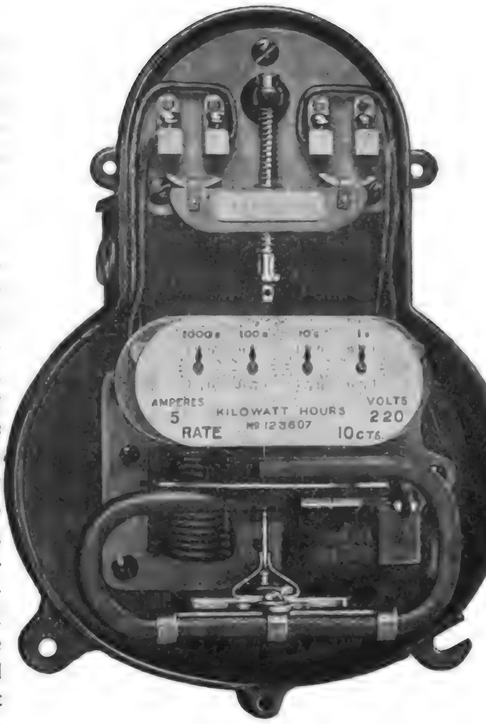


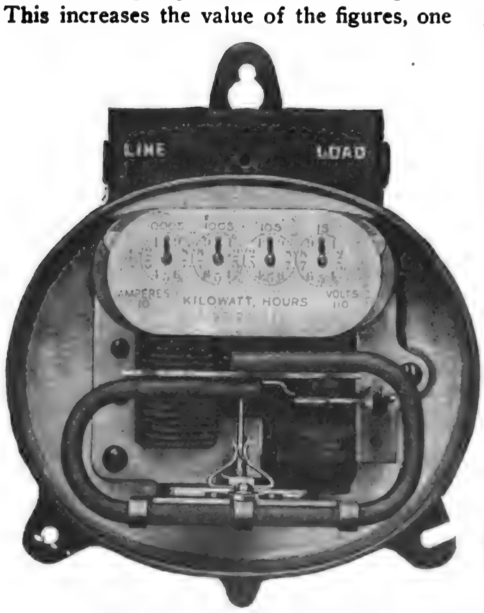
FIG. 3.—PREPAYMENT WATT-HOUR METER.

A new release motion or escapment has been employed in this prepayment meter. Its function is to subtract credit at the same rate that energy is consumed, so that when 10 cents' worth of energy has passed the meter, the prepayment device will show 10 cents less credit.

To do this a pinion connection is made with the registering gear of the meter. The pinion shaft carries a small cam which in revolving, oscillates an eccentric arm that rocks on its elbow, advancing and retracting its finger end across the periphery of the release gear wheel in mesh with a damper fan. This advance and retreat requires one whole revolution of the pinion, one half of which is spent in pushing a catch from the pin set in the rim of the release gear. In so doing the finger displaces the catch and the other half turn is consumed in withdrawing the finger from the pin. When the finger has nearly reached its outer position the release gear is free to revolve, driven by the coil spring acting through a train of three gears. The middle gear in this series is large and makes a single revolution for each release. A pin on this gear wheel pushes the catch back into the path of the stop pin on the release gear wheel and arrests its motion after it has made the necessary number of revolutions to allow the coil spring to turn back the credit figures one place.

These three motions—release, revolution and arrest—constitute the functions of the escapement. The release gear wheel, the stop gear wheel and the credit wheel have a definite ratio of speeds, but the frequency of release is governed entirely by the size of the pinion driving the eccentric arm cam and in mesh with the meter registering mechanism.

The operation of the prepayment device adds no work to the meter's load as the only duty performed by the meter registering train is the tripping or release of the escapement movement. This occurs but once for every rate unit, and consists in moving a tiny brass lever about one-eighth of an inch during this period.



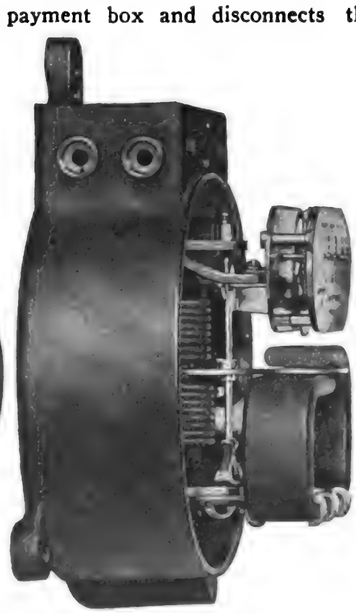


FIG. 1.—FORT WAYNE INTEGRATING WATT-HOUR METER.—FIG. 2.

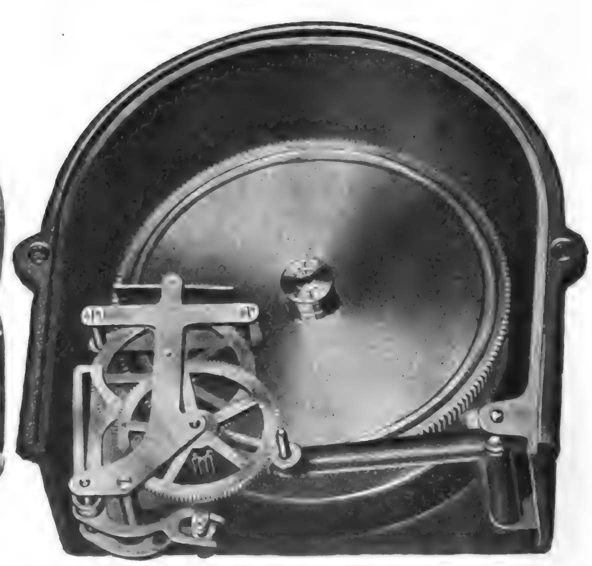


FIG. 4.—PREPAYMENT DEVICE, SHOWING ESCAPEMENT AND SWITCH LEVER.

New Apparatus and Appliances

HIGH-TENSION OIL SWITCHES.

The Hartman Circuit Breaker Company, of Mansfield, Ohio, has for the past four years been developing a line of high-tension oil switches and circuit breakers, and, in the design which is here presented, particular attention has been given to the insulation of the live parts of the switch from the operating mechanism in order that the switch might be installed on the back of the switchboard and used for very high voltages with entire safety to the operator. This has been accomplished by using a new material in oil switch construction, viz., moulded fibre treated by a process which it is said gives to it insulating qualities substantially equal to porcelain. Each pole of the switch is enclosed in a separate tank or cell made of this fibre. The cover of the tank with its two insulators is also made of treated fibre, and the live parts which are enclosed in the tank are completely insulated from the metal supporting frame and operating mechanism. In switches intended for voltages above 6600, the oil tank is moulded in such a way that, together with the wooden switch rod, a complete barrier is interposed between the two arcing points of the switch element. Two, three and four-pole combinations are made up of the single pole element shown in Fig. 1. These are clamped side by side to sections of seamless steel tubing which is fastened rigidly to the switchboard plate. This construction permits of liberal spacing between the poles without increasing the weight of the switch. In the automatic switch or circuit breaker two types are made. In the type shown in Fig. 2 the overload coils are mounted on spools of treated wood and are operated directly from the high potential circuit. This dispenses with the use of current transformers and effects a corresponding reduction in the price of the circuit breaker. The insulation of these coils has been worked out with great care and is entirely adequate for the voltages for which these circuit breakers are recommended. In the second type of circuit breaker which is made, the overload coils are mounted substantially as shown in Fig. 2, and are energized from the secondaries of series transformers. This circuit breaker is made for potentials up to 22,000 volts. Both of these circuit breakers possess the feature that they cannot be closed while an overload exists on any phase of the line. While these switches and circuit breakers were mainly designed for installing on the switchboard, they can also be installed apart from the panel and operated manually by a simple system of cranks and rods, or they can be operated electrically by means of solenoid control. In this case the operating current is derived from the exciters, a storage battery or any convenient source of direct current supply.

FIG. 1.—HARTMAN OIL SWITCH.

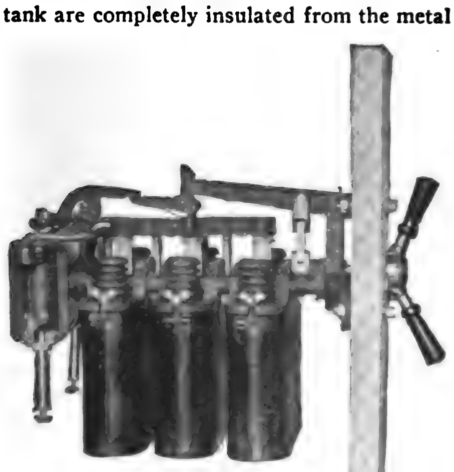


FIG. 2.—OIL SWITCH WITH CIRCUIT-BREAKER.

COMMUTATOR TRUING DEVICE.

Jordan Brothers, of New York City, have developed and placed on the market a commutator truing device which possesses many advantages, chief among which is its ready application to existing machines without the necessity of removing the armature or commutator. The device consists of a grinding wheel mounted in adjustable ball bearings and equipped with appropriate clamps with which to fasten it to the rocker arm or frame of the motor or dynamo. The machine is fastened in position with its shaft parallel to that of the dynamo with the grinding wheel just clearing the commutator. A round belt passes around a driving pulley on the grinding wheel shaft and from there around the end of the commutator or any adjacent revolving portion of the machine. An idler pulley is provided to take up any slack in the belt and to give the proper adhesion. The grinding wheel shaft is movable parallel to the commutator shaft and has sufficient range to sweep over the entire commutator. This shaft is placed on an eccentric sleeve and by the manipulation of the wing nut the grinding wheel may be set in a position to take as light a cut as may be desired. The wheel is slowly fed across the surface of the commutator by means of the handwheel shown. It is evident that the commutator is thereby trued with reference to its center of rotation, which may or may not correspond with the centre marks on the ends of the shaft. The wheel is made of a special composition which is claimed to contain no emery or other mineral injurious to the insulation between the commutator segments. The cut is said to be clean, there being no tendency to drag the copper across from segment to segment. The device is warranted to grind down the copper and mica alike. All parts of the device are interchangeable.

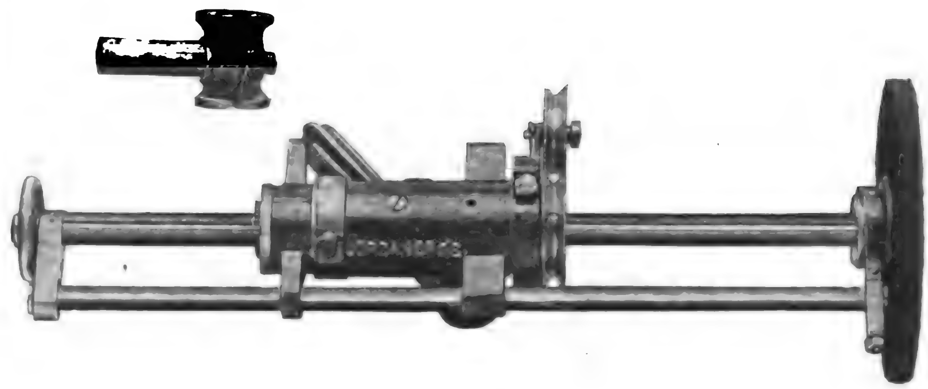


FIG. 3.—COMMUTATOR TRUING DEVICE.

WESTINGHOUSE CIRCUIT BREAKER.

In order to meet the demand for a very compact and inexpensive circuit breaker for both alternating and direct-current circuits, the Westinghouse Electric & Manufacturing Company has produced the type F breaker described below. The circuit breaker is made in 12½, 25, 50 and 75-ampere sizes for 250 volts direct current

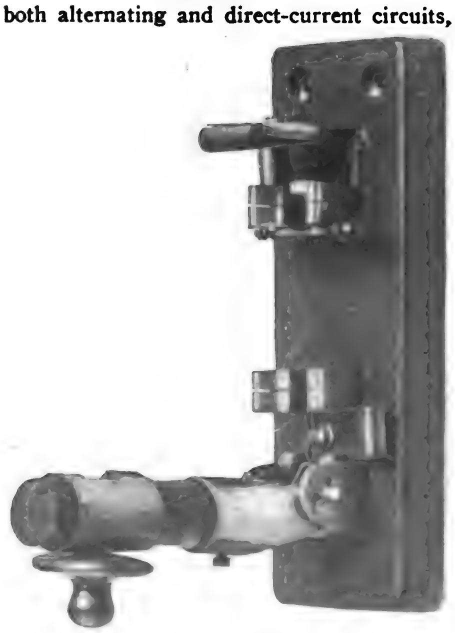


FIG. 4.—CIRCUIT-BREAKER OPEN.

and 440 volts alternating current. They are made in the overload type only. The tripping point is adjusted by turning the thumb screw shown in the illustration, the range claimed being from 80 per cent. to 180 per cent rated capacity. The small insulating knob at the right of the contacts controls a tripping device by raising which the breaker may be opened by hand. By installing a breaker for each wire of the circuit, two for two-wire and three for three-wire circuits, the switch may be dispensed with and the circuit operated by means of the breakers alone. In this case, the breakers are non-closable on overloads, the breaker on one side of the circuit opening when the breaker on the other side of the circuit is closed. An insulating knob is provided for closing. The only depth required in the containing box is that required for the opening of the breaker. Current-carrying contacts are of copper, arcing contacts are carbon and are readily renewable. The lever arm is opened by a spring. The operating solenoid is inside of a fibre tube in the lever arm, which also conduces to a small and compact design. The parts of the breaker are mounted on a neat porcelain block, which is fastened to its support by three screws with countersunk heads. Every effort has been made towards producing a breaker small in size and cost.

FIG. 5.—BREAKER CLOSED.

LINEMAN'S TEST SET.

One of the drawbacks of the magneto in testing is that it gives no idea of the resistance of the circuit other than that it is or it is not greater than that through which a ring can be had with the particular magneto being used. When testing wires in metallic conduits it also frequently indicates a ground when none exists, and two men are required for rapid working. The Whitney tester shown by Fig. 6 was designed to obviate the drawbacks inherent in the magneto, at the same time possessing its good features. It consists of a very simple and strongly constructed voltmeter movement mounted, together with a couple of cells, a small rheostat and a pair of terminals in a small stout box of hard wood. The connections within the box are such that when the cord ends are touched together, the batteries are applied direct to the voltmeter terminals, the rheostat being so adjusted that the voltmeter then shows full scale. Evidently if a resistance were interposed between the terminals, it would be in series with the voltmeter whose needle would then fail to reach full scale deflection by an amount proportionate to the value of said resistance. A table showing what number of scale divisions correspond to different resistances is secured in the cover of the box so that in taking a reading all that need be done is to touch the cord terminals to the circuit to be tested and then read the resistance by reference to the table. As the maximum current that can be drawn from the battery is the small amount required by the voltmeter, it may be expected to last for long periods without requiring attention. The rheostat is made adjustable from the outside by means of a screwdriver so that even after the battery voltage has fallen off the instrument can still be made to give full deflection on a short circuit. The testers are made in two ranges, one giving a readable deflection through 5000 ohms maximum and the other through 25,000 ohms maximum. Machado & Roller, New York, are the selling agents.

FIG. 6.—LINEMAN'S TEST SET.

AUTOMATIC STARTER FOR INDUCTION MOTORS.

Fig. 7 herewith illustrates one of the several types of automatic starters and speed controllers for induction motors recently brought out by the American Electric & Controller Company, of New York City. The starter, which is intended for motors of the squirrel cage type, includes an auto-transformer, not shown, which may be mounted at the back of the panel or located in any other convenient place. The illustration shows the apparatus set to the "on" position for the motor running. A float-switch as shown in the upper left hand corner, a thermostat having electrical contacts or any suitable device acts at the proper time through a small relay at the right of the large upper solenoid, trips a latch and causes the main switch to open at the same time, leaving the circuits ready for starting again. To start the motor the large upper solenoid is first energized; this lifts the plunger and rod, and the latter throws the auto-transformer switch, at the same time cutting off the current in the solenoid, thus allowing the plunger to fall against the retardation of the dash-pot. The transformer switch in the meantime remains closed long enough to permit the motor to reach full speed. The plunger has by this time fallen to its lowest point, and made the connection which energizes the lower solenoid and closes the main switch across the line, throwing out the transformer switch by the same movement, thus completing the cycle. The starter for the slip-ring type of motor is similar in principle, but the plunger of the large upper solenoid carries a cross arm which makes sliding contact with a straight line set of contacts connected to grid resistance in the circuit of the motor secondary. The lower

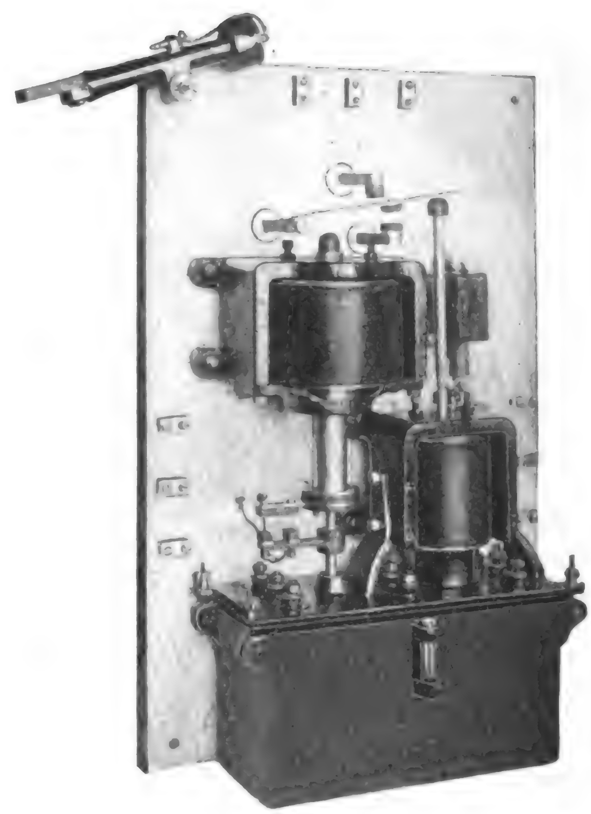


FIG. 7.—AUTOMATIC STARTER FOR INDUCTION MOTORS.

solenoid shown in Fig. 7 is dispensed with altogether. A device may be added to the slip-ring type of resistance starter, making it possible to hold the cross arm and plunger at any desired point along the row of contacts, thus making it serve as an automatic speed regulator as well as starter.

CRESCENT IMPROVED SWITCH.

The Crescent Electrical Manufacturing Company, of Rochester, N. Y., has brought out the improved switch shown by Fig. 8 herewith. The manufacturer calls particular attention to the method of fastening the fibre to the blades, which has been a weak point in many switches. The use of a notch to hold the head of a screw is done away with and a very rigid fastening is made by the use of a hooked form of screw which ensures a permanent connection, it is claimed, at all times. A detail view of this method of attaching the fibre to the blades is shown in the upper corner of the engraving.

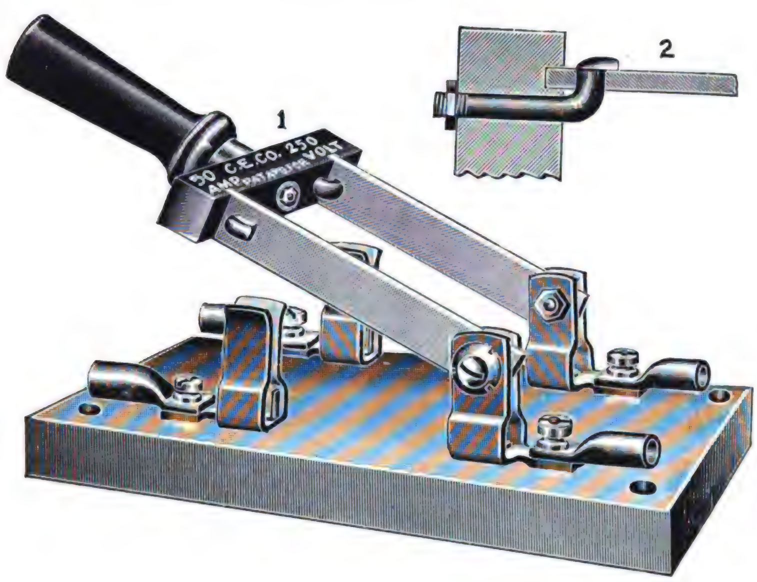


FIG. 8.—CRESCENT KNIFE SWITCH.

NEW ENTRANCE BOX.

The National Board of Fire Underwriters require that at all points where service wires enter a building, at the nearest point practicable a service switch must be installed. This service switch must also be mounted in an iron-clad box, and where the wires are run open or in moulding, they must pass through porcelain-bushed holes in the box. If conduit is used, the box must be suitably arranged for the conduit. The Troy Electrical Company, of Troy, N. Y., has brought out an entrance box consisting of two castings, the cover being nearly as deep as the box itself so as to allow the face of the switch to come nearly flush with the sides of the box. The box is 7½ in. long, 4⅜ in. wide and 4½ in. deep outside. The total length over screw ears is 9¼ in. Mounted in the box is a standard 25-ampere, 110-volt knife switch in combination with a fuse plug cut-out. The boxes are also made a little larger for 220-volt service and for three-wire systems.

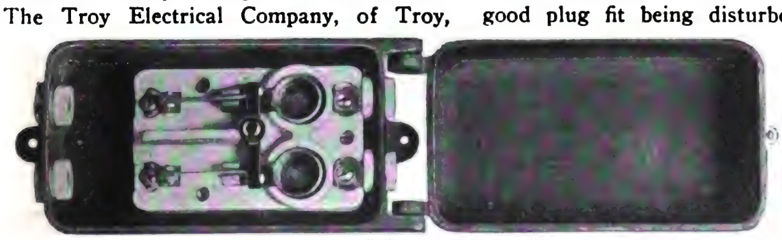


FIG. 9.—TROY ENTRANCE BOX.

NEW DECADE RESISTANCE BOX.

The Leeds & Northrup Co., of Philadelphia, Pa., has brought out a new line of Wheatstone bridges and resistance boxes of the "Decade" type, one of which is illustrated herewith. The illustration shows a resistance box having four rows of resistances ranging from one ohm to ten thousand ohms in the rheostat, and with six resistances in the bridge, all of which may be used in either arm. The advantages claimed for the "decade" plan of connecting the coils in the rheostat over that of the regular "post-office" or other plug-out methods are as follows: Each decade requires but a single plug which is never out of use, as it is either in the zero position or set on some value. It is consequently not easily lost by being laid aside. Since each decade requires but one plug, the values can be read directly from the position of the plug without the mental process of adding up a series of values as in other plans of connections. No block in the rheostat has a plug fitted to two sides of it. This prevents the possibility of a good plug fit being disturbed by the removal of a plug from the other side of the block, which is of advantage in insuring good contacts and accuracy. In this line of boxes, there is a unique arrangement of the bridge arms, which minimizes errors due to contacts and facilitates interchanging the arms. Any one of the coils in the bridge may be connected to either bridge arm, and the bridge can consequently be reversed and the coils interchanged very simply and easily. The resistances are made of wire which has an exceedingly low temperature coefficient and requires no correction at all for accuracies of 1/10 of 1 per cent. for all ordinary changes of temperature. The wire has also a negligible thermo-electric force against copper, and consequently no corrections have to be made in using it. An unusual thickness is given to the hard rubber top for this class of apparatus, in order to prevent the possibility of buckling and to insure continued good plug fits.

FIG. 10.—"DECADE" RESISTANCE BOX.

A NEW TYPE OF WATER TUBE CLEANER.

The "Demon" water tube cleaner illustrated by Fig. 11 herewith, consists essentially of two parts, viz., a scale cutting tool and a motor to drive this cutter. The motor belongs to the general class of rotary engines, but differs from most of these in the essential feature, that it has a central shaft and is free from all valves. The cleaner is designed to operate by water, and the exhaust water is used for washing away the loosened scale. The inlet and exhaust water is taken care of by properly arranged ports. The pistons of the motor, which are three in number, are attached to the shaft, and each in turn automatically projects across the cylinder, thus forming a partition between the inlet and the exhaust ports, which the water must push forward before reaching the exhaust ports. As no water can reach the exhaust until the piston has passed the exhaust ports, the water consumed is directly proportional to the speed at which the machine is revolving. A num-

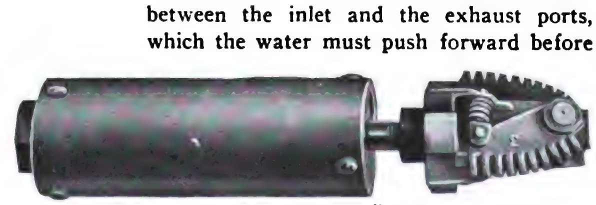


FIG. 11.—"DEMON" TUBE CLEANER.

ber of advantages are claimed for this tool by the manufacturers, one of the most important of which is the great amount of power developed. Another important advantage claimed for this machine is that a form of cutter can be used entirely different from anything else designed for this work. The cutting tool in this machine is designed to cut the scale, in contradistinction to grinding the scale. Three cutters with tooth-like edges are attached to a heavy head, the latter being directly attached to the shaft of the cleaner. These cutters are journaled to the head at the front ends, and slide in grooves at their rear end. They are not thrown out by the centrifugal force, but are forced out by powerful springs, so that they engage the scale in a positive manner. In order to prevent any possible injury to the tubes, and also to relieve the cutters of any friction and wear after the scale has been removed, the outward movement of the cutters is limited by properly arranged stops. The motor or body of the cleaner is centered in the tube by six centering lugs. The journals of the shaft are so constructed that no lubrication is necessary. All wearing surfaces are made as large as possible and of hardened tool steel. This device is manufactured by The General Specialty Company, of Buffalo, N. Y.

FIG. 12.

FIG. 13.

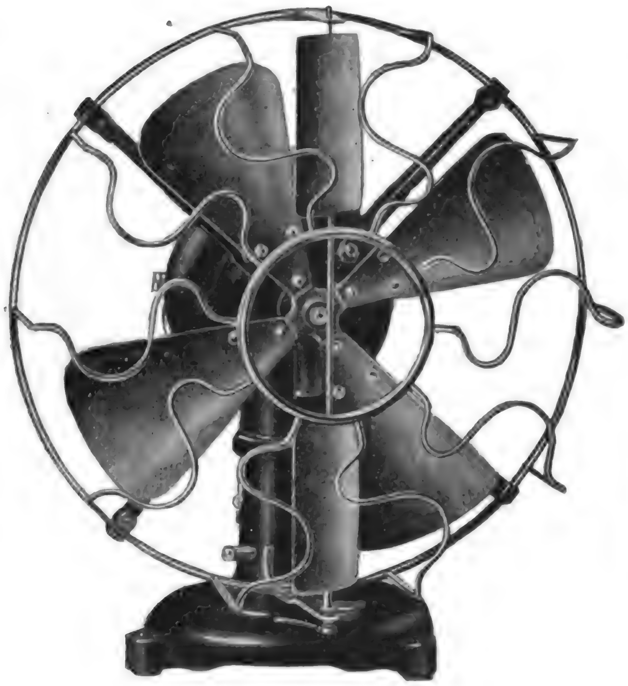


FIG. 14.—COLONIAL OSCILLATING FAN.

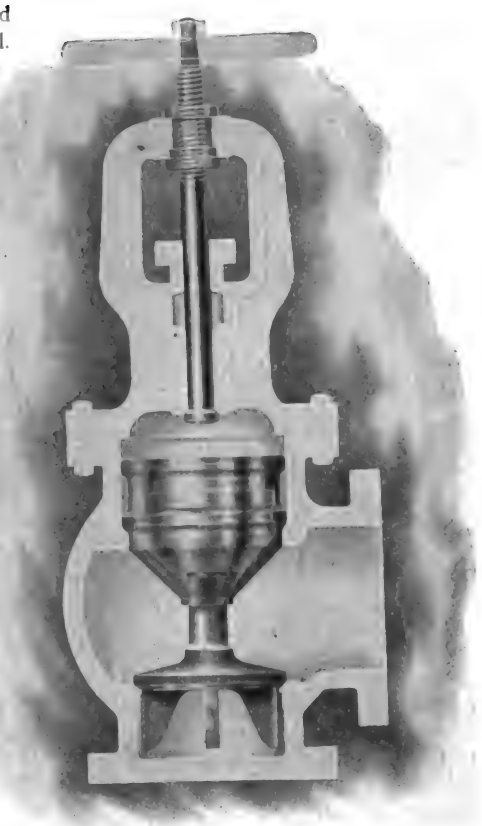


FIG. 15.—CUSHIONED NON-RETURN VALVE.

NEW TAP JOINT.

Dossert & Co., of New York City, have brought out the tap joint illustrated by Figs. 12 and 13 herewith. The assembly of the joint is shown in Fig. 13 and Fig. 12 shows the various parts. The illustrations show at a glance the entire construction. A cast copper hook machined to fit the cable forms the main member of the joint. The shank of this hook is threaded and drilled so as to form a nipple for the standard Dossert joint of the desired size. Upon this shank is secured also a compression nut, which presses upon a suitably shaped casting fitting in the space between the cable and the base of the hook, and forcing it against the cable with a great pressure. The contact area of the hook contact is a machined surface of many times the area of the cable that it surrounds, the portions being adjusted to fit the size of the tap, and in mechanical strength and electrical conductivity, the tap joint is superior to the tap wire, which it serves to connect. The application of the joint is simple. The tap wire may be fastened to the hook by the regulation Dossert coupler provided for that purpose. The main cable is then bared exactly the width of the hook and scraped. The hook is fastened over the wire and the lower casting is slipped in place. The tightening of the compression nut finishes the work, which may then be taped up and will be found to be less bulky and more conducting than any equivalent soldered joint.

COLONIAL OSCILLATING FAN.

The Colonial Fan & Motor Company, of Warren, Ohio, has brought out the oscillating fan-motor outfit shown by Fig. 14. A blade or vane located just inside the fan guard controls the oscillating movement. Collector rings and brushes placed above the switch in the base of the fan make it possible to discard the customary flexible lead connections used in some early makes of oscillators. The deflecting vane is devoid of any freak attachments. The motor travels on tempered ball bearings. The motors are made for 110 and 220-volt circuits and have fans 12 and 16 ins. in diameter. The full speeds are 1650 and 1350 r.p.m. The current consumption is said to be 55 and 77 watts.

ANDERSON CUSHIONED NON-RETURN VALVE.

Fig. 15 herewith shows the Anderson cushioned non-return valve made by the Golden-Anderson Valve Specialty Co., of Pittsburg, Pa. The valves are made in either the angle or globe pattern, and when placed between the boiler and header are claimed to equalize the pressure between the different units of a battery of boilers, as they remain closed as long as the boiler pressure is lower than that of the header. When the boiler pressure equals the header pressure, the valve opens and will remain in that position without chattering or hammering. The valves, the manufacturer claims, will automatically cut off a boiler in case of accident, and will also act as a safety stop. The illustration shows plainly the dash-pot arrangement for cushioning these valves, which is necessary in order to avoid the chattering and hammering common to this class of valve. The valves are adapted for service with superheated steam.

THE STANDARD DESK OR BRACKET FAN MOTORS.

Fig. 16 herewith shows the 1905 model of the Standard desk fan motor made by The Robbins & Myers Co., of Springfield, Ohio. The design combines in a single structure the desirable features of both the desk and bracket fans. The direction of the air current may be adjusted as desired in either a vertical or horizontal plane by means of thumb screws provided for the purpose, so that no tools are required to attain this result. Fans 12 in. and 16 in. in diameter are provided and the motors are built for 110, 220 and 250-volt, direct-current circuits. The amperes required at full speeds at these voltages with a 12-in. fan are 0.45, 0.23 and 0.23 respectively, while with the 16-in. fans the current consumption is 0.65, 0.33 and 0.33 amperes. A three-

speed regulator is provided in the base of the fan, giving speeds approximately as fol-

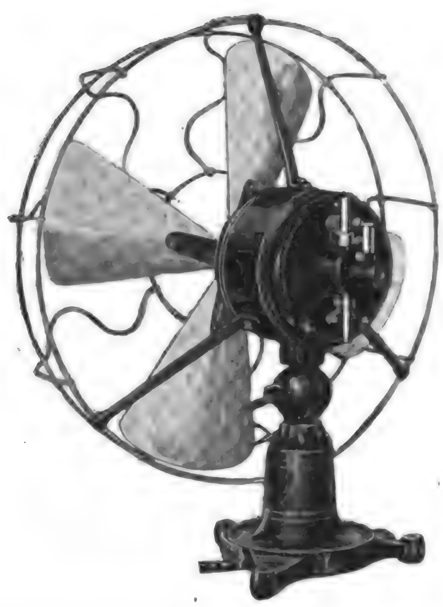


FIG. 16.—THE STANDARD FAN MOTOR

ows: 1,700, 1,300 and 1,000 r.pm. with 12-in. fans and 1,400, 1,100 and 800 r.p.m. with 16-in. fans.

CORNWELL SWITCH BOX.

The R. M. Cornwell Co., of Syracuse, N. Y., has brought out a universal switch box which can be used for either new or old work, where concealed wiring is used. It is

FIG. 17.—SWITCH BOX.

made in two general styles. The first is not made for any special switch, but will fit all standard flush rotary switches, round or square base. The second can be readily applied to all standard push button, flush receptacle or rectangular rotary switches. The boxes may be directly attached to the wood work and are properly drilled and tapped. They are made of cast iron with the required number of holes in the back for wires to enter. The dimensions are 2 3/16 by 3¾ in., and 2¼ by 4 in., with two, three and four holes.

WEINLAND MECHANICAL BOILER-TUBE CLEANER.

The accompanying illustration shows the Weinland mechanical boiler-tube cleaner made by the Lagonda Manufacturing Company, of Springfield, Ohio, at work on a boiler in the large plant of the Colorado Fuel & Iron Company, at Pueblo, Colo. The machine is attached to the boiler front and is driven by a belt from the motor which passes over pulleys on the end of a board attached to the machine at the boiler front. The pulleys on this board are loose and the board itself swings freely from the machine so that it can be moved in any position or at any angle. By this means only one setting of the motor is required. A simple arrangement of block and tackle is attached to the end of the board opposite the motor, and this can be drawn tight so as to hold the board firmly while the machine is in operation; and when moving from one tube to another, the proper slack of belt can be provided. The man at the handle directs the shaft, to the opposite end of which the cutter head is attached, as it cuts its way through the scale in the tube. The motor drives the cutter very rapidly so

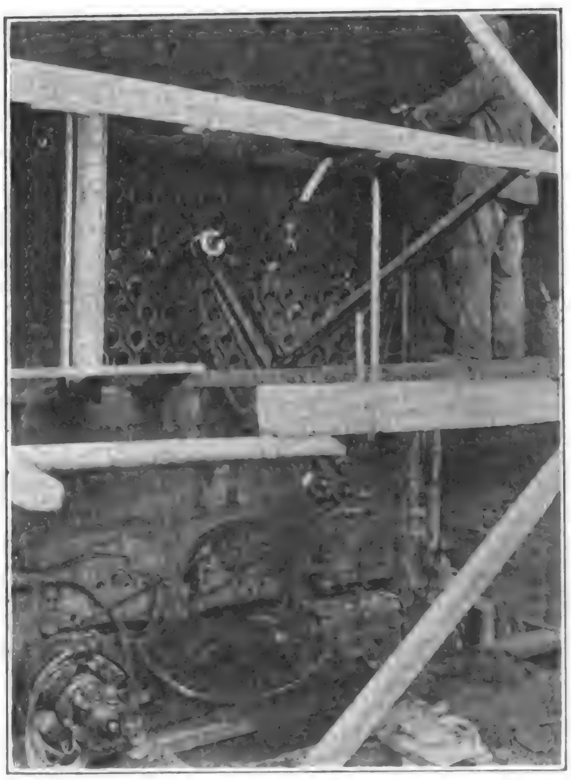


FIG. 18.—WEINLAND TUBE CLEANER IN OPERATION.

that the work is quickly performed and, it is claimed, without injury to the tube.

THE JOHNS-MANVILLE COMPANY AT THE RAILWAY CONGRESS.

The H. W. Johns-Manville Co. had an extremely interesting display of asbestos and magnesia products and electrical specialties at the exhibition in connection with the International Railway Congress held at Washington, D. C., last month. The company was represented by Messrs. T. F. Manville, president; J. E. Meek, who was in charge of the exhibit; L. B. Melville, and James Younglove, manager of the Chicago office. The exhibit attracted a great deal of attention from those at the Congress and elicited unqualified commendation.

STANLEY-G. I. CONSOLIDATION.

The Stanley Electric Manufacturing Company, Pittsfield, Mass., and the General Incandescent Arc Light Company, of New York, have consolidated; the corporate title of the combined interest will be Stanley-G. I. Electric Manufacturing Company. The Stanley Co. as engineers and manufacturers of the well-known S. K. C. system acquired an enviable reputation, and the General Incandescent Arc Light Company is widely recognized as a builder of high-grade arc lamps, alternating and direct-current motors and electrical specialties. The combination is a peculiarly happy one. The officers are William Murray Crane, president; C. C. Chesney, first vice-president; M. D. Barr, second vice-president; M. J. Insull, third vice-president.

DOBLE WHEELS TO BE BUILT IN CANADA.

The Abner Doble Co., of San Francisco, announces that arrangements have been made with the John McDougall Caledonian Iron Works Company, Limited, of Montreal, Canada, whereby the latter becomes sole licensee for the manufacture of the Doble water wheels in the Dominion of Canada. The tangential water wheels and needle regulating nozzles manufactured by the Abner Doble Co. are well known for their excellence of design and workmanship, and considerable engineering interest has recently been shown in relation to the four 8000-h.p. wheels which that company built for operation in California power plants.

The McDougall Co. is said to have the most extensive machine works in Canada, its plant including machine shops, a pattern shop, a foundry, forging works and a structural material shop. The plant is therefore well equipped for the manufacture of water wheels and other hydraulic machinery. They already have in hand the building of a 100-h.p. wheel to operate under a 170-ft. head, taking water through a 3½-in. jet and having a speed of 130 r.p.m.

NEW BOOKS.

THE INDICATOR HANDBOOK, PART II. (Second Edition.) By Charles N. Pickworth. New York: D. Van Nostrand Company. Buckram. 130 pages, 5 inches x 7½ inches; 150 illustrations and several tables. Price, $1.50.

Those interested in the use of steam indicators are doubtless familiar with the previous edition of this little book, as well as its mate, Part I. The present edition has not been changed greatly; the few errors in the 1902 edition have been eliminated and an illustrated description of the Mathot explosion and pressure indicator for gas engines has been added. The author still retains his preference for terminal pressure factors based on the theory that saturated steam expands according to Rankine's law for superheated steam, and disdains to in-

sert a table of mean effective pressure factors for different ratios of expansion. It is unnecessary to say that in other respects the book leaves practically nothing to be desired.

TESTING OF CONTINUOUS-CURRENT MACHINES. By Charles Kinzbrunner. New York: John Wiley & Sons. Buckram; 326 + x pages, 5½ in. x 8½ in.; 249 illustrations. Price, $2.00.

This is intended as a practical handbook for engineers as well as a textbook for advanced students, and it is very well written and arranged. The section describing various instruments, switches, etc., might as well have been omitted, being unnecessary to the class of readers who are far enough advanced to profit by the remainder of the book. The discussion of armature resistance and its measurement is excellent and unusual. The exposition of the so-called "indirect method" of testing efficiencies is not sufficiently clear to be of benefit to anyone not already familiar with it or without enough experience to analyze it independently of the author's effort to explain it. In other respects the book corresponds very closely to the other high-grade works of the same general scope which have been published.

ALTERNATING-CURRENT MACHINERY. By William Esty, S.B., M.A. Chicago: American School of Correspondence. Cloth; 420 pages, 6½ in. x 9½ in.; 380 illustrations. Price, $3.75.

This is far and away the best literary production from the American School of Correspondence that has thus far come to the reviewer's notice. The author describes briefly the fundamentals of alternating-current generators of the standard types, the synchronous motors, the rotary converter, the induction motor, the transformer, and all of the usual instruments; there is also a section devoted to switchboards and appliances, which includes special apparatus such as synchronizers, inductive regulators, motor-operated switches, etc. The principles of each class of apparatus are thoroughly explained and their application in practical work is also discussed as fully as space considerations will allow. While there are some irrelevant half-tone engravings interspersed with the germane illustrations, the proportion of these is conspicuously smaller than in previous publications of the same establishment. Taken as a whole, this book is highly commendable to electrical students of all grades, not excepting those already in graduating classes, to whom it will undoubtedly be useful as a reference book.

THE THEORY OF THE LEAD ACCUMULATOR (STORAGE BATTERY). By Friedrich Dolezalek. Translated by Carl L. von Ende. First edition. New York: John Wiley & Sons. 1904. Cloth; 241 + xi pages; 7¼ inches by 4¾ inches; 30 illustrations. Price, $2.50.

This is an excellent exposition of the subject. Since the translation of Reynier until this work appeared there has been no book published in the English language that presented the theory of the lead accumulator in a satisfactory manner. Reynier discussed all types of accumulators that, up to that time, had had any industrial application, while the present work is confined to the lead cell. This is, to some extent, an index of the manner in which the accumulator was then and is now regarded by the electrical public. When Reynier's book was written, there were strong hopes of the ultimate success of several types of accumulators; at the present time, the lead accumulator is the only one of any commercial importance.

The subject is treated in a systematic manner, although the headings of the chapters, in some instances, are a little misleading. For example, the first chapter is headed "Chemical Theory of Origin of Current," which is unobjectionable, but the second chapter is headed "Thermodynamical Theory of Origin of Current," as though this were a rival theory; whereas, the thermodynamic theory does not, strictly speaking, account for the origin of the current, but of the electromotive force; that is, the question whether or not an electric current will be produced, in given circumstances, is not determined by the thermodynamic theory but, given a current due to any particular chemical reaction, the thermodynamic theory will account for all the energy changes and, hence, the electromotive force. The third chapter is headed "Osmotic Theory of the Origin of the Current"; another theory which, according to its votaries, is not opposed to the thermodynamic theory, but supplements it. An enumeration of some of the other chapter headings will give an idea of the scope of the book: "Variation of Electromotive Force with Acid Concentration," "Variation of Electrode Potential with Acid Concentration," "Temperature Coefficient," "Influence of External Pressure," "Behavior During Charging and Discharging," "Reversability," "Changes in the Open Cell," "Internal Resistance," "Capacity," "Degree of Efficiency and Working Efficiency," "Changes in the Cell During Formation," "Methods of Measurement," "Table of Density and Percentage Strength of Mixtures of Sulphuric Acid and Water." This table is made on a somewhat different plan from the sulphuric acid tables usually found in chemistries and works on the storage battery, giving 0.001 parts acid at specific gravity 1. This is due, apparently, to the fact that the gravity of the acid is given for a temperature of 15° C., while the standard is water at 4° C.

In discussing the measurement of internal resistance, the author says "the method still in use of getting at the internal resistance from the difference of potential between the cell in open and closed circuit is quite as full of error, because the polarization which sets in upon closing the circuit frequently exceeds the loss of potential through the internal resistance." This is so, providing the true internal resistance be required for scientific purposes; but, for engineering purposes, the quantity sought is usually that which may be called the effective resistance, being of more engineering importance than the true resistance.

PERSONAL.

MR. J. T. BAKER has been appointed district manager of the Aurora (Ill.) Division of the Western United Gas & Electric Company.

MR. W. L. DRIESBACH, of Easton, Pa., has purchased the entire property of the Watkins (N. Y.) Gas & Electric Light Company.

MR. W. S. McGOWAN, JR., has been appointed Eastern Sales Manager of the American Brake Shoe & Foundry Company, with headquarters at 170 Broadway, New York.

MR. P. A. McCARTHY has been reappointed City Engineer by the city authorities of Lufkin, Tex., and has appointed Mr. J. P. Starns his chief deputy and Mr. Frank McCarthy, assistant deputy.

MR. LAMAR LYNDON, the well-known consulting engineer, has removed his offices from the Park Row Building to No. 80 William Street, New York. The telephone number has also been changed, from 1650 Cortlandt to 4527 John.

MR. A. P. HEAD, London representative of the Wellman-Seaver-Morgan Company, recently completed a tour around the world in the interests of his company. While on this trip Mr. Head established sub-agencies in all the principal cities of Australasia and India.

MR. ALBERT S. CRANE has been appointed chief hydraulic engineer of the J. G. White Company's staff. Mr. Crane has been actively engaged in hydraulic engineering since his graduation from Cornell University in 1891, and is widely experienced in his branch of work.

MR. W. G. SCHRON, formerly of the sales department of the Westinghouse Machine Company, has entered the service of the Allis-Chalmers Company, and will make his headquarters at the Pittsburg office and devote his attention to the sale of gas engines, steam engines and steam turbines.

MR. FRANCK Z. MAGUIRE has established offices at 10 Wall Street, New York, for the sale of American and foreign patents. Mr. Maguire is well known in his field on both sides of the Atlantic, having maintained offices in London for more than ten years and transacted business extensively in this country also.

MR. H. J. SLIFER has been appointed steam railway expert for the J. G. White Company, New York, and is now in responsible charge of all matters relating to the company's steam railway undertakings. Mr. Slifer is a graduate of the Polytechnic College of Pennsylvania, and has had extensive and diversified experience in railroad engineering, bridge construction and kindred lines.

MR. A. S. WESSLING, of the Bullock Electric Manufacturing Company's staff, recently made a tour of the principal universities and colleges where technical courses in applied mechanics are given and delivered a lecture on "Methods of Control for Variable Speed Motors," in which he made special reference to the control of machine-tool motors and described in detail the features of the Bullock multi-voltage system.

MR. FRANK C. RANDALL, previously vice-president and general manager of the National Electric Company, Milwaukee, has accepted the managership of the Allis-Chalmers Company's New York office. Mr. Randall is well known throughout electrical and street railway circles, having been active in these fields for the past ten or twelve years. Prior to his connection with the National Company he held an important position with the J. G. Brill Company.

MR. WILLIAM C. HUBBARD, for several years with the Westinghouse Electric & Manufacturing Company, has severed his connection with that company and entered the sales department of the Cooper Hewitt Electric Company, New York. Mr. Hubbard has had long experience in the lighting field. For two years he was vice-president and general manager of the Electric Arc Light Company, and afterwards New York manager for the Manhattan General Construction Company until both companies were absorbed by the Westinghouse interests.

TRADE PUBLICATIONS.

MERCURY VAPOR LAMPS.—Cooper Hewitt Electric Company, New York.—Bulletin No. 6, devoted to mercury vapor lamps for general illumination indoors.

STEAM SPECIALTIES. Golden - Anderson Valve Specialty Company, Pittsburg, Pa.—A convenient little catalogue devoted to Anderson valves and cocks and Golden tilting traps.

RECORDING THERMOMETERS. The Bristol Manufacturing Company, Waterbury, Conn.—Catalogue No. 28, in which is described the complete line of Bristol recording thermometers for all classes of service.

RAILWAY GENERATORS. Crocker-Wheeler Company, Ampere, N. J.—This is Bulletin No. 52, superseding No. 26 and devoted to an illustrated description of large direct-current railway generators.

CONSTANT-SPEED DYNAMOS AND MOTORS. Electro-Dynamic Company, Bayonne, N. J.—This is Circular No. 11 in which are briefly described Types L and S direct-current dynamos and constant-speed motors.

DIRECT-CONNECTED STEAM ENGINES. Chandler & Taylor Company, Indianapolis, Ind.—This is Bulletin No. E-101, devoted to "Class 1425" enclosed automatic engines for direct connection to electric generators.

SHAWMUT CONDUIT OUTLET BUSHING. Chase-Shawmut Company, Newburyport, Mass.—Bulletin No. 31, in which are convincingly presented the advantages of the new outlet bushing manufactured by this company under the Erickson patent.

MOTOR - DRIVEN PROPELLER FANS. Crocker-Wheeler Company, Ampere, N. J.—This is Bulletin 54, and it contains illustrations and a short description of Crocker-Wheeler motors as applied to the driving of Davidson propeller-type ventilating fans.

WATER POWER EQUIPMENT. The Wellman-Seaver-Morgan Company, Cleveland, Ohio.—This is a handsome publication of standard catalogue size containing illustrated descriptions of the Jolly-McCormick turbines built for relatively low heads.

DIRECT - CURRENT SWITCHBOARD PANELS. General Electric Company.—Bulletin No. 4408, containing an illustrated description of a new line of "double-pole" direct-current switchboard panels for use in conjunction with generators and rotary converters (direct-current side, of course).

ROLFE ELECTRICAL SPECIALTIES. Rolfe Electric Company, Rochester, N. Y.—A book of vest-pocket size containing illustrated descriptions of some of the specialties manufactured by this company and a presentation of the fundamental electric laws and definitions of the principal terms used in electric practice.

MONARCH ENGINE-STOP AND SPEED-LIMIT SYSTEM.—The Consolidated Engine Stop Company, New York.—This is an attractively executed booklet containing an illustrated description of the Monarch system, some strong arguments concerning it and a partial list of satisfied users.

BIJUR STORAGE BATTERY. General Storage Battery Company, New York.—Catalogue "A," of standard size, containing a profusely illustrated description of the high-duty storage cell described in this paper last month. The catalogue is well executed and the contents are unusually well arranged from the standpoint of the user.

HIGH TENSION TROLLEY LINE CONSTRUCTION. Westinghouse Electric & Manufacturing Company.—Circular No. 1110 containing a liberally-illustrated description of the Westinghouse catenary line construction employed for high-tension alternating-current trolley lines in conjunction with the company's single-phase railway system.

LIGHTING OF HOTELS AND CLUBS. Holophane Glass Company, New York.—This is a companion book to the artistic productions noticed in this department of previous issues and is fully up to the standard set in the preceding publications. The book is profusely illustrated and the arguments in favor of Holophane glass are well supported.

EXPERIMENTAL DYNAMOS AND MOTORS AND CASTINGS. Parsell & Weed, New York.—Bulletin 9051, containing an illustrated description of a small Brocksmith dynamo or motor which is built in several styles and furnished either complete or partly finished and singly or in motor-generator style. The castings alone are also supplied to those wishing to do their own machine work and assembling.

FAN-MOTORS. The Emerson Electric Manufacturing Company, St. Louis, Mo.—Catalogue No. 4050, containing illustrations and specifications of a new line of direct-current desk and bracket fan-motors brought out this year. These machines are somewhat similar in appearance to the well-known alternating-current motors built by this company, but differ considerably in constructional details. They are built in conventional sizes.

STEAM BOILERS, HEATERS AND ENGINES. The Brownell Company, Dayton, Ohio.—Catalogue No. 54, of standard size, devoted to the well-known Brownell engines, boilers and feed-water heaters. The engines are automatic and of the side crank type, mostly self-contained; the boilers are built in both vertical and horizontal types, and the heaters in both the open and closed types. The book is well executed and attractive in appearance.

BUSINESS NEWS.

THE WESTINGHOUSE MACHINE COMPANY has opened new branch offices at Atlanta, Ga., Charlotte, N. C., Cincinnati, Denver and San Francisco.

G. M. GEST, New York, has been awarded the contract for a complete underground conduit system for the Consolidated Electric Light Company, Portland, Me.

THE AMERICAN ELECTRIC & CONTROLLER COMPANY, New York, has removed its headquarters from 12 Dey Street to the Electrical Exchange Building, 136 Liberty Street.

L. E. JEANNIN informs us that he has established his electrical supply business at Ottumwa, Iowa, and not at Orlando, Fla., as stated in this column last month.

THE KEYSTONE LUBRICATING COMPANY, Philadelphia, has established an office at 253 Broadway, New York, in charge of Mr. W. F. Bilyeu, who will be glad to discuss with interested persons the merits of Keystone grease.

LOCKE INSULATOR MANUFACTURING COMPANY, Victor, N. Y., has broken ground for a two-story addition to its factory plant, the new building to cover an area 50x150 feet. The company is also erecting two large porcelain kilns.

THE REEVES ENGINE COMPANY, Trenton, N. J., has removed its Chicago office from the Monadnock Building to the Ellsworth Building, 355 Dearborn Street. The telephone number has not been changed.

EUGENE MUNSELL & CO., and the MICA INSULATOR COMPANY, New York, are sending out to the trade an attractive blotter printed in two colors and announcing the removal of their Chicago offices from 117 Lake Street to 358 Dearborn Street.

THE UNDERFEED STOKER COMPANY, Chicago, wishes to call attention of Electric Light Convention delegates to its Denver sales agency, in charge of Gilbert Wilkes & Co., 435 Seventeenth Street, where visitors will be welcome at all times.

THE TRUMP MANUFACTURING COMPANY, Springfield, Ohio, reports a good demand for its well-known turbines in the electrical and railway field. A railway company in central New York has just ordered a pair of the largest size of Trump horizontal wheels for power-station work.

WILMINGTON FIBRE SPECIALTY COMPANY, Wilmington, Del., has brought out a very complete line of hard fibre cleats for electric wires. Among the advantages embodied in this line are the recognized superiority of fibre over wood in toughness, absence of grain and lower degree of inflammability.

H. W. JOHNS-MANVILLE COMPANY, New York, has found it absolutely necessary to establish more branch offices in order to facilitate the handling of its business and promote the convenience of its customers. Branches have therefore been established at San Francisco, Seattle, Los Angeles, Kansas City, Little Rock and Minneapolis.

MISSOURI AMERICAN ELECTRIC COMPANY, St. Louis, Mo., has brought out a new incandescent lamp the principal feature of which is the method of sealing the tip; instead of leaving a sharp projecting point, as in the usual type, the tip is sunk flush with the contour of the bulb. The construction and its advantages can better be appreciated by inspection.

THE CANADIAN WESTINGHOUSE COMPANY, LTD., reports among recent sales that of a 200-kw. railway generator and a number of car motors to the Edmonton Street Railway Company; also the sale of a 500-kw. turbine-generator to the Canadian Pacific Railway Company, to be installed at Fort William for the purpose of supplying power to various grain elevators there. The unit is to deliver three-phase currents at 600 volts and 30 cycles.

WAGNER ELECTRICAL MANUFACTURING COMPANY, St. Louis, Mo., has opened a branch office at San Francisco, in the Rialto Building, and will hereafter transact all of its Pacific Coast business through its local manager, Mr. A. J. Myers, who has been identified with the company's interests in that section for the past ten years. Sub-branches will soon be established at Los Angeles and Seattle.

THE LOWE ELECTRIC COMPANY has been organized by Mr. Ernest A. Lowe, formerly of the firm of Lowe & Leveridge, and its general office is located at 35 Dey Street, New York. The new company has taken over the manufacturing plant and business of Robert L. Hailey, and Mr. Hailey is a stockholder and the secretary of the company. The company will conduct a general electrical supply business and a repairing and manufacturing department, the latter being under Mr. Hailey's supervision.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY is not complaining of dullness in its lines. Alternating-current generators, exciters, direct-current railway generators and motors, alternating-current motors and transformers, switching apparatus, etc., have all been sold in large quantities during the past few weeks. The Wisconsin Light & Power Company recently placed with the various Westinghouse Companies orders covering the entire steam and electrical equipment of a large lighting and power plant.

SOUTHERN ELECTRICAL COMPANY, Nashville, Tenn., informs us that the growth of its business has led to a complete reorganization. The company will hereafter restrict its field to the sale of apparatus and supplies and discontinue contract work entirely. Mr. Oscar C. Turner, for a long time connected with the Western Electric Company, has taken an interest in the Southern Company and becomes its vice-president and manager. Mr. Felix Shwab remains president and Mr. Wm. M. Bowles, secretary.

ALLIS-CHALMERS COMPANY, Milwaukee, reports a continuance of brisk trade in its manifold lines. A large contract was recently closed for electric apparatus for an extensive increase in the power-house equipment of the San Joaquin Power Company, Fresno, Calif., the additional machinery aggregating 3000 horse-power. The Tuolume Electric Company, San Jose, Calif., has also ordered a large quantity of additional machinery in the way of alternating-current generators, transformers, etc., and other large contracts for equipment of the same general class are in hand. A large number of sales of smaller machinery and accessory apparatus is also reported.

CENTRAL STATION NEWS

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

ALABAMA.

BIRMINGHAM.—The Brighton Waterworks & Power Company has been incorporated, with a capital of $10,000.

CARBONHILL.—It is proposed to construct water works and an electric light plant at a cost of $25,000 to $35,000. No engineer has been selected as yet. J. S. Shannon is chairman of the Light Committee.

TUSCUMBIA.—The Mussel Shoal Electric Company has been organized with a capital of $10,000 for the purpose of supplying electric light and power, heat, etc., from Mussel Shoals. The incorporators are Thos. H. Jackson, Memphis, Tenn., Jas. Jackson, of Tuscumbia, and others.

MONTGOMERY.—The Montgomery Light & Water Power Company has changed hands. Mr. W. F. Vandiver as president has sold his holdings in said company to Mr. McMillan, of New York. The company will shortly be reorganized. The company furnishes lights to the city of Montgomery and electric power to each of the two electric railway companies of this city.

ALASKA.

NOME.—Thaddeus Avery, Jr., chief engineer of the Sawtooth Electric Power Company, was married April 12 at San Francisco to Miss Stella E. Morse.

ARIZONA.

WINSLOW.—The Winslow Electric Light & Power Company has petitioned the Council for a franchise for transmitting electrical power for lighting purposes.

ARKANSAS.

YELLVILLE.—Isaac Emery has petitioned the Council for a franchise for the establishment and maintenance of an electric light plant.

PRAIRIE GROVE.—A franchise has been granted to C. L. Cummings for an electric light plant. Immediately after the publication of the ordinance the necessary machinery will be bought, and as the power will be furnished by the Prairie Grove Milling Company's engine, the installation of the dynamo and the necessary wiring are all that is to be done.

LITTLE ROCK.—Articles of incorporation were filed recently by the Merchants' Investment Company of Little Rock, the purpose of which is to promote, construct, own and operate electric light and power plants for the production, generation and furnishing of electric supplies, light, heat and power, and selling the same to consumers. The officers are: C. J. Kramer, president; Wm. S. Mitchell, vice-president; J. B. Wishendorff, secretary; Harry Lasker, treasurer. The directors are: S. J. Beauchamp, Harry Lasker, P. J. O'Brien, Albert Pfeifer, G. H. Bowser, Albert D. Cohn, T. B. Martin, Jr., J. J. Mandlebaum, Wm. Bracy and Wm. S. Mitchell. The capital stock is $250,000, of which $56,000 has been subscribed, and is divided into 10,000 shares of the value of $25 each. It is understood that the company will immediately start the erection of its plant in this city.

CALIFORNIA.

VISALIA.—It is stated that bids will be received until June 5 for an electric franchise in the city. Eugene L. Scott, County Clerk.

ANAHEIM.—The Board of City Trustees has authorized Engineer A. L. Lewis to prepare a report on the extension of the electric light plant and an increase of the water supply.

WHITTIER. — The Edison Electric Company will rebuild its distributing system at this point. The changes to be made at the central station will double the capacity of the present system.

SANTA BARBARA.—The Edison Company will establish a 1,500-h.p. motor generator at its local plant, and is to run a line shortly from the immense Kern River plant to Santa Barbara.

MADERA.—A Merced company is desirous of furnishing electric light and power to Madera, and will invest a capital of $100,000. The proposition has been brought to the notice of the Madera Board of Trade.

LOS ANGELES.—The San Joaquin Light & Power Company, recently organized, has filed articles of incorporation, showing a capital stock of $8,000,000. W. G. Kerekhoff and A. C. Balch are among the incorporators of the new concern.

SAN DIEGO.—The San Diego Consolidated Gas & Electric Company is about to absorb the San Diego Gas & Electric Light Company of this city. A large amount of new capital will be expended by the new company in the way of extensions to the existing plant.

SANTA BARBARA.—The Merchants Mutual Electric Light Company, which is being formed by merchants of Santa Barbara in opposition to the Edison Electric Company, is now ready to commence the construction of its plant at Santa Barbara.

SAN JOSE.—Mr. Chester H. Pennoyer, who recently resigned from the service of the California Gas & Electric Corporation as manager of its united gas and electric system in this city, has taken the management of the Pacific Coast office of the National Conduit & Cable Company, San Francisco.

ANGELS.—R. E. Starkweather and C. E. Wishon of the California Gas & Electric Company have been at Angels recently, planning an extension of the Standard Company's electric line through Calaveras, Tuolumne and Merced Counties to furnish power to the mines and lights for the mining belt.

EUREKA.—The survey of the pole line from Eureka to Loleta for the North Mountain Power Company has been completed, and it is understood that actual construction work will be rushed rapidly forward. A sub-station is to be established at Loleta and the Fortuna Lighting Company will tap the line at that point.

STOCKTON.—Leopold Wallach, of New York, has placed a $5,000,000 bond issue for the Stanislaus Electric Power Company. The company is to build a power plant at Murphys and supply energy to Stockton, San Jose and San Francisco. It will generate, if necessary, 24,000 horse-power for light and power purposes. Work on the new plant has commenced.

SEBASTOPOL.—Sealed bids will be received by Wm. T. Searles, town clerk of Sebastopol, June 6, for a franchise to construct and operate poles, wires, transformers and other conductors for the transmission of electricity for electric light and power purposes and to operate electric light and power system there, as applied for by the Sebastopol Light, Power & Water Company.

SAN FRANCISCO.—At the recent annual meeting of the stockholders of the American River Electric Company, held in San Francisco, plans were discussed for extending the company's electric transmission system, operating from the power house near Placerville, to Stockton ,Cal., and intermediate points. The following directors were elected: M. Fleishhacker, F. H. Buck, H. Fleishhacker, W. Bell, A. Anderson, W. E. Gerber and S. C. Scheeline.

SAN FRANCISCO.—Articles of incorporation of the Loon Lake Water & Power Company (successor to the California Water & Mining Company) have been filed with the County Clerk. The company is incorporated for $200,000, with $500 worth of stock subscribed. The officers of the new company are Cleaveland B. Forbes, president; C. M. Fitzgerald, vice-president and general manager; Stanley Forbes, treasurer. The company's principal place of business is in San Francisco.

RENO.—The Reno Power, Light & Water Company's generating station at Reno, Nev., has met its second accident within a month. The first shutdown was attributed to obstructions getting into the pipe line and damaging the hydraulic end of the plant to the extent of several thousand dollars. A temporary supply of current for lighting was then obtained from the transmission plant of the Truckee River General Electric Company, at Floriston, Cal. The plant was started up recently, but after one day's operation broke down again from some cause. Transformers were burned out, and the damage to machinery is estimated at $7,000 this time.

SAN FRANCISCO.—At the annual meeting of the San Francisco Gas & Electric Company, the old board of directors were reelected. There was no change made in the officers of the company, who are W. B. Bowen, president; A. H. Payson, first vice-president; C. Osgood Hooker, second vice-president, and Charles L. Barrett, secretary and treasurer. By the end of the present year the concentration of nearly all of the engine-driven units in the Potrero electric power station will have been accomplished. The Jessie Street plant is being rebuilt as a model sub-station and by the middle of next year its last remaining steam engine will have been removed. About 2,000 horse-power is being purchased under contract from the Standard Electric transmission line, owned by the California Gas & Electric Corporation. The meter department is also being thoroughly overhauled. A new and more satisfactory system of testing meters on the consumers' premises has been inaugurated and a number of additional inspectors have been added.

COLORADO.

SALIDA.—Reports state that the Edison Electric Light Company and the Salida Light, Power & Utility Company, both of this city, have been consolidated and the two plants will be combined at an early date.

PUEBLO.—Mr. A. W. Linn has esigned his position as superintendent of motive power for the Pueblo Light & Power Company, which is controlled by the Pueblo Suburban Traction & Lighting Company, to accept the position of general manager of the street car system of Seattle, Wash.

CONNECTICUT.

HARTFORD.—The Hartford Electric Light Company has been authorized to issue bonds to the amount of $2,000,000, and to increase its capital from $1,600,000 to $3,000,000.

WILLIMANTIC.—Mr. Arthur E. Jackman, for some time manager of the Willimantic Gas & Electric Light Company, will locate in Boston, Mass., as manager for the Adams-Bagnall Company, of Cleveland, O. His offices will be in the Boston *Journal* Building.

DELAWARE.

WILMINGTON.—At a meeting of the stockholders of the Delaware Electric Light, Heat & Power Company the following officers were re-elected for the ensuing year: President, E. E. Neff; treasurer, M. Miller; secretary, J. G. Rosenthall; general manager, E. F. Gwynn.

DOVER.—The Consumers' Light, Heat & Power Company has been incorporated with a capital stock of $1,000,000. The incorporators are William M. Fook, of Chicago; James L. Wolcott and James H. Hughes of Delaware. The Citizens' Light, Heat & Power Company, an auxiliary concern to the above, has also been incorporated with a capital stock of $300,000.

WILMINGTON.—The Wilmington Electric Light & Power Company, which was incorporated recently at Dover, with a capital of $1,000,000, has organized by electing the following officers: President, Charles C. Kurtz; secretary, Stanley Baker; manager of the Delmarvia Telephone Co.; treasurer, Henry Baird; directors, Henry P. Scott, Horace W. Gause, Samuel K. Smith and Charles C. Kurtz of this city, and George R. Webb, of Baltimore, Mr. Webb being largely interested in

both the Maryland and Delmarvia Telephone Companies. President Kurtz is said to have stated that the company would begin to erect a power plant as soon as a franchise is secured, and it is hoped to begin business very soon. One of the chief objects of the company is to heat dwellings. It also proposes to furnish current for light and power.

FLORIDA.

EUSTIS.—Armstrong & Smith have petitioned the Council for a franchise for water works and an electric light plant.

MONTICELLO.—The Monticello Power Company has been incorporated with a capital of $10,000 to operate an electric light and power plant.

OCALA.—The Florida Power Company has been incorporated with a capital of $300,000 by W. N. Camp, R. F. Brewer, G. D. Munsing and others.

TARPON SPRINGS.—It is proposed to construct an electric light plant and ice factory, at a cost of $6,000. Address N. F. McDonald, engineer in charge.

ALACHUA.—The Alachua Ice & Water Company has been incorporated with a capital of $25,000. It will construct an electric light plant. Incorporators: R. L. Stringfellow, R. R. Livingston and others.

ST. AUGUSTINE.—At a recent meeting of the City Council a communication was received and read from Gen. J. C. R. Foster, submitting a proposition to install an electric lighting, heat and power plant in this city. It is understood that a company is being formed, which will be known as the St. Augustine Gas & Electric Light Company and that the new plant will be installed as soon as the franchise has been granted.

GEORGIA.

JACKSON.—J. B. McCrary, of Senoia, has been selected to prepare plans for water works and an electric light plant.

MONROE.—The citizens have voted to issue $15,000 bonds for an electric light plant. J. B. McCrary, of Senoia, is engineer.

OCILLA.—The City Council has decided to call an election to vote on issuing $20,000 bonds for water work and an electric light plant.

AUSTELL.—It is proposed to construct an electric light plant to cost from $2,500 to $3,000. No engineer has been selected as yet. C. J. Shelverton is Mayor.

PELHAM.—W. H. Maury, of the recently incorporated Pelham Electric Light Company, writes that he will receive bids at once for an electric light plant to cost $12,000.

TALLAPOOSA.—J. Edgar Black and J. E. Gelder are formulating plans for the erection of a new electric light plant here and are investigating the cost of a plant of sufficient size to supply a town of 2,500 population.

LOUISVILLE.—C. F. Wagoner has resigned his position as manager of the city electric light and water works plants to accept a position as first assistant mechanical engineer of the Terminal Station at Atlanta, this State.

HAWKINSVILLE.—The city of Hawkinsville has rescinded a 10-year contract offered by the Hawkinsville cotton mills to light the streets, and an election will probably be held on the question of issuing bonds for a municipal electric lighting plant.

COLUMBUS.—Developments of considerable magnitude are being projected near Columbus. H. H. Hunt and Henry G. Bradlee, of Stone & Webster, Boston, have expressed the opinion that to develop the Clapp's factory water power will soon become a necessity, this being located two miles from Columbus. The Stone & Webster people will likely develop 10,000 horse-power on the Chattahoochee River.

COVINGTON.—The City Council of Covington has approved the proposition of the White Shoals Power Company to supply electricity for lighting the municipality, the terms including the loan of $45,000 in city bonds. An election will be called to vote on this bond issue. The White Shoals Power Company will have a capital stock of $150,000, and intends to develop waterpower on the Alcovey River, ten miles southeast of Covington.

HAWAII.

HONOLULU.—The Public Works Department of this city has just completed plans and specifications for a new hydraulic-electric station in Nunann Valley. Bids on same have been advertised and the building is to be finished by the 15th of June.

HONOLULU.—Deeds have recently been recorded at Honolulu, Hawaii, by which the financing of the Kauai Electric Company will be carried out with the aid of the McBryde Sugar Company. Over $200,000 will be spent on the plant. The plantation is to pay about $36,000 per year for the power and water. The McBryde Company also pays over $150,000 of its second issue of bonds, and guarantees $150,000 of the electric company's bonds.

IDAHO.

JULIETTA.—Armstrong & Morrison have purchased the mill and electric light business of Holbrook & Son.

LEWISTON.—Francis Jenkins and associates, of Moscow, Idaho, are giving attention to plans for the establishment of a large power plant at Elk Creek Falls, where the minimum capacity is about 3,500 horse-power.

WEISER.—In regard to the construction of a power plant on Weiser River, the work is not assured yet, but it will probably be done. If the plant is constructed it will cost $50,000. Pitts, Ellis & Co. are interested in this plant. A. E. Fox is the engineer.

AMERICAN FALLS.—The new plant of the American Falls Power, Light & Water Company has been completed and is supplying electrical power to Pocatello and other points. The plant has a capacity of 2,500 horse-power, of which 1,250 is at present being utilized.

BOISE.—The Utility Power Company, Ltd., has filed articles of incorporation, with a capital of $300,000. J. L. Weaver, Frank Martin, L. J. Weaver, Henry Fitch and B. A. Dare are named as the incorporators. The company will establish plants for the generation and distribution of electricity.

BOISE.—The Western Power Company, which contemplates the installation of a 10,000-h.p. power plant, has been organized with the following officials: J. B. Coate, president; L. A. Coate, secretary and general manager; I. V. Howard, vice-president; A. J. Wilson, electrical engineer; G. R. Pritchet, Lee Bunch and C. F. Dill, directors.

PAYETTE.—The City Council has granted three franchises to William and Sinclair Mainland, Eastern capitalists, one for a gas plant, another for an electric-light plant and the third for electric railways. Work on the light plant must begin within twelve months, and cars must be running on the railways within eighteen months.

ILLINOIS.

GEORGETOWN.—The Georgetown Electric Company will expend about $15,000 in improvements.

CARLINVILLE.—C. W. Carr, of Virden, is interested in the construction of an electric light plant in Carlinville.

EDWARDSVILLE.—The Pana Electric Light plant has been sold to A. H. Bickmore & Co., the representatives of a New York syndicate.

MANSFIELD.—The trustees of the village of Mansfield have decided to buy the light plant recently erected here. The consideration is said to be $7,000.

ROCK ISLAND.—It is reported that the village trustees are contemplating the installation of an electric light plant for lighting the streets of the village.

MASON CITY.—There is talk of constructing an electric light plant, but nothing definite has yet been done. It is stated that an election will soon be held to vote on the question.

ODIN.—The citizens of Odin have indorsed the action of the Town Board in regard to lighting the village by electricity, the power for lighting to be furnished by the Odin Coal Company.

CHARLESTON.—The Charleston Gas & Electric Company has been sold to the Charleston Illuminating Company for a consideration of $240,000. Congressman W. B. McKinley, of Champaign, heads the new company.

KIRKWOOD.—The Kirkwood Electric Company, which has just been incorporated with a capital of $12,000, will operate an electric-light, heat and power plant in Kirkwood. J. F. White, J. F. Taylor and R. M. Houston are the incorporators.

PAWNEE.—Arthur Carswell has purchased the electric light plant from Alvin Underwood.

EAST ST. LOUIS.—The St. Clair Light & Power Company, of East St. Louis, has obtained a franchise from the East St. Louis City Council to erect poles and to string wires and furnish electricity in East St. Louis, provided that within a year the company constructs an electric light plant with appliances to cost not less than $50,000. C. L. Gray is president of the company and R. W. Sikking is secretary. The company was recently incorporated for a nominal sum.

INDIANA.

FLORA.—Dr. Ross, of Wabash, is interested in the construction of an electric light plant at Flora.

PLAINFIELD.—W. W. Wilson, of Danville, has received the contract for constructing an electric light plant at Plainfield.

KEWANNA.—The Kewanna Light Company has been incorporated with a capital of $15,000. Dr. A. Armstrong is president.

ALEXANDRIA.—The Alexandria Electric Light & Power Company has decided to install a new system and add 25 arc lamps to the city lighting system.

CROWN POINT.—The Crown Point Electric Company is making arrangements for the rebuilding of its plant. Many improvements will be embodied in the new plant, which will have a greater capacity than the old one.

MARION.—The Citizens' Heat & Light Company, at a recent directors' meeting, decided to go out of business. An assessment of one per cent. will be levied on all stockholders to meet the obligations of the company.

RICHMOND.—The municipal electric lighting and power plant seems to be growing in favor and increasing its net receipts a little each month. The superintendent's report for April shows that the receipts for lighting and power were $4,417.04, and the operating expenses $1,567.10, leaving a net balance of $2,849.94 to be turned over to the city treasury.

ELKHART.—The fight between the Hen Island dam interests, which furnish the electric light and power for South Bend, Mishawaka and Elkhart, and the Elkhart City Electric Company is ended by the purchase of the latter by Charles A. Gapen, who is believed to represent the Hen Island syndicate. The consideration is said to be $250,000, which is less than the plant cost.

MONTICELLO.—The Tippecanoe Hydraulic Company is the name of a new company incorporated recently to utilize the waterpower in the Tippecanoe River near Monticello. The capital stock is $300,000. A. A. McKain, of Indianapolis, is president. It is proposed to build four dams about six miles apart, the first to be built at once at Norway, one mile north of Monticello. In this plant the company will invest $196,000. The company proposes to furnish electricity for lights and power to Lafayette, Logansport, Delphi, Monticello, Brookston and Frankfort. Mr. McKain has purchased all the land adjacent to the power sites. There is much interest manifested in the project, which is deemed perfectly feasible. C. D. Meeker and D. W. Thompson, Jr., of Frankfort, are also interested.

FRANKFORT.—Capitalists of this city and Kokomo have organized the Indiana Hydraulic Company, with a capital stock of $200,000, and filed articles of incorporation. The company was organized with officers as follows: Eugene Rush, Frankfort, president and general manager; J. C. Dewees, Kokomo, vice-president; N. W. Hanna, Frankfort, secretary and assistant manager; Judge

J. V. Kent, Frankfort, treasurer and general counsel. These men own all of the stock. It is given out that the company will manufacture electricity, and they claim that they have already contracted for their entire output to an electric railway company that contemplates building a road in the State within the year. The company has already determined upon its location, but for the present declines to make this public. They will build a dam of solid cement thirty feet high and 368 feet in length, and claim that the water-power thus obtained will be sufficient for all demands.

INDIAN TERRITORY.

SULPHUR.—The Sulphur Light & Power Company has been incorporated with a capital stock of $100,000.

WYNNEWOOD.—The Council has granted S. E. Hutchins, of Whitehall, Wis., a franchise for an electric light plant.

MUSKOGEE.—H. Von Schon, Wayne County Bank Building, Detroit, has been selected by the Grand River Power Company (C. N. Haskell, president, Muskogee) to report on the water development of Grand River. About 11,000 horse-power is probably feasible within a reasonable transmission distance from Muskogee.

TISHOMINGO.—C. N. Wells, of Tishomingo, and other interested parties have engaged H. Von Schon, Wayne County Bank Building, Detroit, Mich., to examine and report on the water power development of Blue River. If the engineer's report is favorable a company will be organized headed by C. H. Wells, of Tishomingo.

IOWA.

CONRAD.—This city is to have an electric light plant soon.

GLENWOOD.—The Glenwood electric light plant is to be enlarged and improved.

SHELDON.—O. E. Logan has let the contract for the construction of a large power plant.

SIOUX CITY.—The Sioux City Gas & Electric Company will expend about $100,000 in improvements.

ESSEX.—There seems to be considerable agitation here in favor of establishing a municipal electric light plant.

IOWA FALLS.—The Peterson Light, Heat & Water Company of Iowa Falls proposes building a power line to Alden.

CLARINDA.—Plans are being prepared by the Lee Electric Light Company for the erection of a new power house here.

FORT MADISON.—The Fort Madison City Council has voted to install thirty-six additional arc lamps for street lighting.

DUBUQUE.—The City Council is discussing the question of putting in incandescent electric lights in the alleys of the business part of this city.

OTTUMWA.—Contracts have been let by the Ottumwa Traction & Light Company for the building of a new power house in this city and the installing of new machinery at an approximate cost of $150,000.

IOWA FALLS.—The Iowa Falls Electric Light & Power Company's heat and light plants have been transferred to the Pearson Heat, Light & Water Company, a Des Moines corporation. The present officers will be retained. The transfer follows an option given the Des Moines company's agents a short time ago. It is stated that the new company contemplates improvements and will add a heating system.

WATERLOO.—Mr. Austin Burt, the newly elected president of the Iowa Electrical Association, is general manager of the Waterloo & Cedar Falls Gas & Electric Light Company. Mr. Burt was born in Detroit 35 years ago and received a public school education, later going to Cornell University. Before completing his course as mechanical engineer at Cornell, he left to accept a position with the E. P. Allis Company, and for five years was assistant to Mr. Edwin Reynolds. In 1900 he returned to Cornell to complete his course and get his degree as mechanical engineer. His graduating thesis was on a test of the Buffalo street railway, of which he had charge. Upon graduation he was elected a member of Sigma Xi, the scientific honor society, and also won the Sibley prize in mechanical arts, both of which serve to show his high attainments as an engineering student. Upon graduation he took the management of the Cedar Falls Light, Heat & Power Company. In 1902, this company was consolidated with the one at Waterloo, and Mr. Burt became superintendent of the electrical department. Later he was made general manager of the whole property. He has always been a most useful member of the Iowa Electrical Association, and the Association has made a very wise choice in placing him at the head for the coming year. His ability to thoroughly analyze all operating problems and to make intelligent operating statistics in bettering conditions, make him valuable both to the company and to the Association.

KANSAS.

RANTOUL.—The Rantoul Light & Heat Company has been incorporated with a capital of $2,000.

MINNEAPOLIS.—R. E. Jackman is said to have sold his mill and electric light plant to S. E. Jackman.

TOPEKA.—The question of combining the city electric light plant with the Harrison Street pumping plant of the water works is under consideration.

FRONTENAC.—Both the street railway company and the Mount Carmel Coal Co. are applicants for a franchise for lighting the city by electricity.

COTTONWOOD FALLS.—The City Council is reported to have granted W. G. Smith, of Bolivar, Mo., a franchise for an electric light and power plant.

WINFIELD.—The special election to vote on the proposition to issue bonds to the amount of $15,000 for completing the electric light plant was lately carried.

GIRARD.—The city of Girard has engaged W. K. Palmer, consulting engineer, Kansas City, Mo., in connection with improvements about to be made in the electric lighting plant and water works of this city.

HUTCHINSON.—The Committee on Lighting has submitted a report to the City Council, recommending the construction of a municipal electric light plant at a cost of $25,000, and to contract with Emerson Carey to furnish the current to the plant.

LAWRENCE.—An option on the Lawrence electric light plant has been given to a company to be known as the Lawrence Light, Heat & Power Company. The stockholders of the new company are Lawrence men, and it is the intention to take over the property at once and to make repairs, changes and improvements. It is planned to spend about $30,000 at once in an enlargement of the plant so it will be adequate to meet the demands upon it.

KENTUCKY.

NEWPORT.—Bids will be received by the General Council of the city, on June 8, for the exclusive franchise to lay, maintain and operate gas pipes, etc.

CENTRAL CITY.—B. F. Creel writes that a company is about to be organized to construct an electric light plant at a cost of $10,000. R. B. Culbertson is also interested.

CARLISLE.—Press reports state that the City Council will soon offer for sale a 10-year lighting franchise, agreeing to pay $90 per arc light per year for 25 or more lights to burn all night.

PADUCAH.—David G. Wright, of St. Louis, Mo., and other St. Louis and New York capitalists are interested in the construction of an electric light and power plant here, to cost from $300,000 to $500,000.

DANVILLE.—The Danville Light, Power & Traction Company has been organized in this city by electing Hon. Chas. C. Fox, local attorney, as president of the concern. The other officers chosen were: Walter T. Scott, of Georgetown, Ky., vice-president; Arnold Honegger, of St. Louis, Mo., secretary, treasurer and general manager. Work has been commenced on the new power house, which will be pushed to completion as rapidly as possible.

GEORGETOWN.—The Georgetown Water, Gas, Electric Light & Power Company has been reorganized under the style of the Georgetown Water, Light, Heat & Power Company, and has filed articles of incorporation showing its capital stock to be $250,000. A steam-heating plant will be added to the equipment and a new gas plant will be erected. The incorporators are named as David J. Hauss and Ross Holzman, of Cincinnati; R. W. Nelson and F. X. Long, of Newport, and S. L. Allen, of this city.

LOUISIANA.

ROBELINE.—This town is to be supplied with electric lights.

LAKE CHARLES.—The City Council is reported to have decided to call an election to vote on issuing $60,000 bonds to build a municipal electric light plant or purchase plant of the local electric light company.

NEW ORLEANS.—The formal transfer of the plant of the Capital Light & Power Company to the Baton Rouge Electric & Gas Company has taken place. The plants of both companies will be operated until the plant of the Baton Rouge Electric & Gas Company is enlarged.

SHREVEPORT.—J. F. McCulloch, of St. Louis, Mo., estimates the cost of constructing a municipal electric light plant at $171,000. This provides for a plant with a capacity of 10,000 incandescent lights of 16 candle-power each and 200 street arcs of 2,000 candle-power each.

MAINE.

DOVER.—The Eastern Electric Company has filed articles of incorporation, with a capital stock of $10,000. W. C. Woodbury is president, and F. E. Guernsey is treasurer, both of this city.

PORTLAND.—The Centerville Light & Trac- Company is installing a complete underground conduit system. G. M. Gest, of New York and Cincinnati, was awarded the contract for the work.

PORTLAND.—The Centerville Light & Traction Company, of this city, capitalized with $500,000, has been incorporated by M. W. Baldwin, H. E. Mason and others, to operate an electric lighting plant.

BUCKFIELD.—Articles of incorporation have been filed by C. N. Taylor, of Wellesley, Mass., and H. A. Irish and F. R. Dyer, of Buckfield, for the Buckfield Water, Power & Electric Light Company. The company's capital is placed at $25,000.

CARIBOU.—The new owners of the Caribou Water, Light & Power Company, George W. Irving, J. P. Donworth and E. E. Haynes, have taken possession. George W. Irving was chosen president, E. E. Haynes, general manager and treasurer; J. P. Donworth, clerk.

BANGOR.—The Emerson Lumber Company, of Bangor, is planning to install an electric lighting plant at its new mill in Island Falls, the intention being to have an installation large enough to furnish street lights in the adjacent villages and to supply current to stores and residences.

MARYLAND.

BALTIMORE.—The Mount Washington Electric Light & Power Company has begun the erection of a new power-house on the site of the present one. The power-house will be twice the size of the old one and will be built of brick and steel. The roof will be of slate. The building will be equipped with the most improved machinery when completed. John A. Sheridan & Co. have been awarded the contract for the erection of the building.

HAGERSTOWN.—The Street Commissioners of Hagerstown will enlarge the municipal electric light plant and have awarded to the Buckeye Engine Company a contract to put in a 500-h.p. engine at a cost of $7,285, and a contract has been given to the Westinghouse Electric Company to put in a generator for $5,750. This will double the capacity of the electric plant, which is now being operated at a profit. According to a report just submitted the streets of Hagerstown during the past year were lighted at a cost of $44.43 per arc light a year, against $00.59 the previous year. Prior to the establishment of the municipal plant the city paid the Hagerstown

Street Railway Company $75 per arc light a year.

MASSACHUSETTS.

NORTHBORO.—The Blair Light Company has been chartered with a capital of $75,000. Thomas H. Blair is president and treasurer.

EASTHAMPTON.—The directors of the Easthampton Gas Company have voted to construct a new electric light plant for street lighting.

HAVERHILL.—E. P. Shaw has made a proposition to the Amesbury Electric Light, Heat & Power Company to supply electric light at Salisbury Beach.

WELLESLEY.—The citizens have voted to appropriate $32,000 for the construction of an electric lighting substation. The town will purchase current from Vincent Goldthwait, of Westboro.

NANTUCKET.—E. A. Chapel, Receiver's Agent, Nantucket Gas & Electric Co., writes that from $10,000 to $25,000 will be expended in improvements. No engineer has been appointed as yet.

NORTHAMPTON.—The Northampton Electric Lighting Company has placed an order with the Buckeye Engine Company, of Salem, Ohio, for a tandem compound engine of 625 horse-power, to take the place of a 100-h.p. Corliss engine.

LYNN.—The Lynn Gas & Electric Company has applied for permission to increase the capital stock by 2,300 shares at par value $100 a share. The company contemplates the immediate expenditure of about $526,700 for gas, electrical and other equipment.

FALL RIVER.—The stockholders of the Fall River Electric Light Company have voted to increase the capital stock from $350,000 to $600,000, the increase to be used for the construction of a new generating plant on the company's wharf property and also to extend its system of distribution.

CHELSEA.—The Chelsea Board of Aldermen has passed the order authorizing the installation of a new street lighting system. The order authorizes the mayor to obtain bids. The number of arc electric lights in the city will be cut down to 74, and the incandescent system will be employed.

MICHIGAN.

ALBION.—The Council has granted a 30-year franchise to the Albion Electric Light Company.

GRAND RAPIDS.—A franchise has been granted to the Grand Rapids & Muskegon Water Power & Electric Company.

BATTLE CREEK.—The citizens are reported to have voted in favor of municipal ownership of the gas and electric light plants.

HOWARD CITY.—A 10-year franchise has been granted A. O'Donnell, of this city, by the Council to furnish electricity for all uses.

TRAVERSE CITY.—A committee has been appointed to visit plants in certain Michigan cities and prepare prices on a plant of from 100 to 200 light capacity.

SAULT STE. MARIE.—W. F. Kingman, who has for some time been general manager of the Edison Sault Electric Company, has accepted a position as manager of the power department of the Detroit Edison Company.

MENOMINEE.—Wm. Holmes, of Menominee, writes that it is proposed to develop the water power of Menominee River, at a probable cost of $250,000, but nothing definite has yet been done. Engineer, N. M. Edwards, of Appleton.

SAULT STE. MARIE.—The Edison Sault Electric Company is reported to have filed a mortgage for $500,000, the proceeds to be used in extending the power plant. The first section of the new plant will develop between 2,500 and 3,000 horse-power.

DETROIT.—The Miami Avenue station of the Detroit Edison Company was the scene of an accident in the bursting of one of the large generators which was running at the rate of 635 r.p.m. Pieces of the commutator were thrown in every direction, doing considerable damage. The manager's desk which stood near by was entirely demolished.

ROSE CITY.—The Rose City Manufacturing Company is figuring on putting in a city electric lighting plant. Andrew King, an electrician of Bay City, has been figuring out the cost. Superintendent W. A. Humphrey will confer with Greif Bros., of Cleveland, who own the plant of the company and thinks it probable that the city will soon be lighted by electricity.

MINNESOTA.

GIBBON.—This town is considering the construction of an electric light plant.

ATKIN.—It is stated that the Aitkin Power & Light Company will construct a water power plant at a cost of $20,000.

MARSHALL.—It is reported that improvements have been recommended to the water works and electric light plant.

MELROSE.—Oscar Claussen, of St. Paul, will prepare plans for the proposed water works and electric light plant. The probable cost of work will be $30,000.

MOORHEAD.—Bids have been advertised for furnishing a 300-k.w. generating unit for the electric light plant, at a probable cost of $20,000. E. P. Burch, Minneapolis, is the engineer.

SOUTH ST. PAUL.—The South St. Paul Power, Heating & Lighting Company is about to petition the Village Council for a franchise. Emil Erick and John Coates are among the incorporators.

MINNEAPOLIS.—The Hughes Electric Company, of this city, recently filed articles of incorporation with a capital stock of $100,000. A central lighting plant will be established, supplying both gas and electricity, at a cost of about $50,000.

MISSISSIPPI.

STARKVILLE.—It has been voted to issue $8,000 bonds to improve the water works and electric plant. T. M. Cummings is city clerk.

LAUREL.—The Laurel Improvement Company has been granted a franchise by the city of Laurel for a light and power station. It will begin at once the erection of a $25,000 plant.

MONTROSE.—The Montrose Lumber Company will ask for a charter with a capital of $25,000 to construct an electric light plant and water works among other enterprises. Incorporators: John O. Gusham, W. P. Hutto and others.

GREENVILLE.—The Greenville Light & Power Company is reported to have purchased the stock and plant of the Delta Electric Light, Power & Manufacturing Company, but none of the particulars of the transaction have been made public at the present writing.

MERIDIAN.—The Mayor and Boards of Aldermen and Councilmen have granted L. W. Ullman a franchise for the operation of an electric light and power plant for a period of 45 years, also the contract for lighting the city for 5 years at $69.50 each for 200 arc lights.

HATTIESBURG.—The organization of the Hattiesburg Traction, Light & Power Company, capitalized at $250,000, has just been perfected with the following named officers: President, H. A. Camp, Lumberton; first vice-president and general manager, H. L. McKee, Meridian; second vice-president and chairman of executive committee, George L. Hawkins; secretary and treasurer, A. F. Thomasson.

MISSOURI.

JOPLIN.—The board of public works is preparing to spend $30,000 on the city's electric light plant.

BRECKENRIDGE.—At a special election a proposition to bond this city for $10,000, for the purpose of putting in an electric light plant, was carried.

MONTANA.

HELENA.—The Rocky Mountain Development Company, capitalized at $50,000, recently filed its articles of incorporation. Among those projecting the new enterprise are F. L. Sizer and A. W. Martin.

GLASGOW.—A. W. Mahon, city engineer, writes that estimates have been submitted to the mayor and Council for water works and an electric light plant; a sewerage system will probably be constructed, too, the entire cost to be $60,000.

NEBRASKA.

WISNER.—The special election held recently to decide the matter of issuing bonds to the amount of $9,000 for the constructing of a lighting system for the village, resulted in a victory for the bonds.

GRAND ISLAND.—The citizens have voted to construct an electric light plant, to cost not more than $35,000. It is proposed to vote on bonds later, which action will determine the matter. C. A. Baldwin is city engineer.

OMAHA.—The city has entered into a four-year agreement with the Omaha Electric Light & Power Company, whereby the latter is to light the city's streets for $75 per light per year. This is a reduction of $19.50 from the present rate. The city is to use at least 600 lights at all times.

ALMA.—Bids will be received by the City Clerk until June 8 for furnishing material and constructing an electric light plant and water works system, consisting of approximately a 10-in. tubular well, power house, machinery setting, etc.; two 60-in. x 14-ft. return flue tubular boilers and one 150-h.p. heater, one 60-h.p. high speed engine, a 40-k.w. direct-current dynamo, fixtures, poles, wire, lamps, etc., a simple, duplex steam fire pump, a boiler feed pump and a deep well power pump, about 1½ miles of water pipe with hydrants, valves, etc., a standpipe or elevated steel tank and tower; also gas producer plant. M. A. Earl, Contracting Engineer, 1416 First National Bank Building, Chicago, Ill.

HASTINGS.—The city of Hastings has arranged with Allis-Chalmers Company, of Milwaukee, for an equipment of an electric lighting plant. The generating unit will consist of a heavy-duty cross-compound Reynolds Corliss engine, with cylinders 14 and 22 in. in diameter and a 36-in. stroke, direct-connected to a single-phase Bullock alternator. The engine will be constructed at the West Allis Milwaukee Works and the electrical apparatus furnished by its electrical department, the Bullock Electric Manufacturing Company, of Cincinnati. The generator is to be provided with an exciter, rheostats and other auxiliary apparatus, and a switchboard panel will be installed.

NEVADA.

RENO.—The power plant of the Reno Power, Light & Water Company has been almost wrecked again. The transformers were burned out and damage to the extent of about $7,000 is reported.

NEW HAMPSHIRE.

LACONIA.—Mr. F. H. Corson has become superintendent of the Winnipesaukee Gas & Electric Company, of this city. He had held this position before.

CONCORD.—At a meeting of the stockholders of the Concord Electric Company in this city, it was voted to increase the preferred stock of the company by a new issue of $50,000. The proceeds will be used for perfecting the company's plant at Sewall's Falls.

NEW JERSEY.

PLEASANTVILLE.—The Shore Electric Light Company has sold its plant to the new Atlantic City Company, which obtained a franchise from the Borough Council.

HIGHTSTOWN.—Mayor Norton is agitating the matter of municipal ownership, but his resolution submitted to the Council did not seem to be considered very favorably.

BEVERLY.—The Cinnaminson Electric Light, Power & Heating Company, of Riverside, has secured the contract for lighting the city by electricity for five years, at $2,850 per year.

TRENTON.—The National Light & Improvement Company has been incorporated here with a capital of $2,000,000, to supply cities with gas and electric light. Incorporators: H. C. Scott, of St. Louis, Mo.; L. B. Dailey and Thomas F. Barrett, both of Jersey City.

PATERSON.—The Paterson Electric Light, Heat & Power Company has been incorporated with a capital stock of $500,000. The incorpora-

tors are Peter S. Van Kirk, Angelo H. Knapp, Thomas J. Arnold, Mangold H. Ellenbogen, Robert Gaede, Walter Bamford and Joseph Bamford.

BRANCHVILLE.—The certificate of incorporation of the Branchville Electric, Water, Power & Lighting Company has been filed in the clerk's office, at Newton. The incorporators are Charles H. Crisman, of Branchville; Samuel S. Wills, of Andover, and E. T. Wills, of Stanhope. The company is capitalized at $30,000, and has $1,000 paid in.

NEW YORK.

ILION.—The Governor has signed the bill legalizing issue of bonds for the repair of the electric light plant.

WATKINS.—The property of the Watkins Gas & Electric Light Company has been sold to M. L. Dreisbach, of Easton, Pa., for $7,500.

AUBURN.—The City Council has let the contract for lighting the city with electricity to the Auburn Light, Heat & Power Company.

WATERFORD.—The Waterford Electric Light, Heat & Power Company has filed a certificate of increase of capital from $50,000 to $500,000.

BLASDELL.—The Blasdell Electric Company has been incorporated; capital, $50,000. J. B. Wall, of Buffalo, is one of the incorporators.

WATERFORD.—The Waterford Electric Light, Heat & Power Company of Waterford, has increased its capital stock from $50,000 to $500,000.

NYACK.—A franchise has been granted the Rockland & Orange County Electric Company, of Monroe, to establish a line in the town of Chester.

HERMON.—Cullimore & Killelea, of Hermon, are interested in the construction of an electric light plant. Geo. Gould, of Ogdensburg, is the engineer.

PHOENIX.—The Phoenix Fuel, Light & Water Company has been incorporated with a capital of $100,000 by J. O. Hawley and L. C. Hall, of Canandaigua.

CHATHAM.—The Lindenwald Light, Heat & Power Company, of Chatham, has been incorporated; capital, $25,000, to operate in Columbia County and the City of Hudson.

CAZENOVIA.—The Cazenovia Electric Company has been incorporated; capital, $30,000. Incorporators: R. F. Hubbard, of Cazenovia; R. S. Brewster, of New York, and others.

HEMPSTEAD, L. I.—The Nassau & Suffolk Lighting Company has been formed at Hempstead; capital, $50,000. Directors: S. M. Havens, D. T. Ackerly and F. C. Henser, New York.

NEW YORK CITY.—The Marshall Light, Heat & Power Company has been formed; capital, $150,000. Directors: H. G. Villard, Gustav Ulbricht, Roger Lewis, all of New York City.

UTICA.—The Central New York Power Company, of Utica, has been incorporated; capital, $1,000,000. Directors: Wm. E. Lewis, Utica; Harry Patton, Whitesboro and others.

NORTH TONAWANDA.—It is stated that bids will be received until June 6 by Geo. J. Smith, City Clerk, for lighting the city for a period of one or three years from August 1, 1905.

FULTON.—The Overland Power Company has been incorporated; capital, $20,000. Directors: Simon B. Storer and Geo. W. Pulver, of Syracuse, and Louis W. Emerich, of Fulton.

NEW YORK CITY.—Plans have been filed for a three-story power station to be constructed by the New York Edison Company on First Avenue and 39th Street. It will cost about $1,500,000.

YONKERS.—The Lawrence Park Heat, Light & Power Company has been incorporated with a capital stock of $50,000. The directors are W. V. D. Lawrence, J. J. Lannin and A. W. Lawrence, New York.

CANTON.—The electric light company plans to make improvements in its plant to the extent of $10,000. New buildings will be erected, and two 100-h.p. engines and one 120-kilowatt generator will be installed.

TROY.—The Troy Public Service Company has been incorporated, to operate in Rensselaer and Albany Counties; capital, $100,000. Directors: Michael F. O'Connor, Chas. S. Aldrich and Edw. Murphy, 2d, of Troy.

HOLLEY.—The Village Trustees are stated to have granted the Niagara Falls Electric Transmission Company a franchise to erect poles and construct lines in the village for electric light, heat and power purposes.

TROY.—The Troy Public Service Company has been formed at Troy to supply gas and electricity for light, heat and power purposes; capital, $100,000. Directors: Michael F. O'Connor, Charles S. Aldrich and Edward Murphy, 2d, Troy.

BELLPORT.—The Bellport Lighting Company has been incorporated with a capital of $10,000. Directors: Edmund F. Hawkins, Isaac H. Cleaves, George Carman, Alfred S. Osborne, Everett M. Price, William F. Gardner and Henry E. Corwin, of Bellport.

OSSINING.—The Northern Westchester Lighting Company, of Ossining, has been incorporated with a capital of $1,000,000, to supply gas and electricity for light, heat and power purposes. Directors: Wm. J. Bagnell and Jas. H. Hagerty, of Brooklyn; Alex. Keogh, of New Rochelle, and others.

SARATOGA SPRINGS.—P. F. Roohan, formerly superintendent of the Saratoga Springs Electric Light & Power Company, has been appointed manager of the lighting and power division of the Hudson River Power Company, with special charge of the plants between Albany and Glens Falls.

SANDY HILL.—The Glens Falls Light Company, of Glens Falls, has secured a 50-year franchise to operate in Sandy Hill. The company will furnish incandescent lights for 10 cents per k.w.-hour and supply current for manufacturing purposes at 5 cents per k.w.-hour; 2,000-c.p. arc lights to be $70 per lamp per year.

BROOKLYN. — The Interinsular Heating, Lighting & Power Company has been incorporated to manufacture and sell gas and electricity for light, heat and power purposes in Queens, Suffolk, Nassau and Richmond; capital stock, $50,000. Directors: John Eckhardt, of New York City; Elbert D. McLean, of Yonkers, and Edward A. Cracke, of Brooklyn.

ALBANY.—The Electric Power & Transmission Company of Niagara County has filed articles of incorporation with the Secretary of State. It has $5,000,000 capital, and may operate anywhere between Albany and Buffalo. Its directors are Edward B. Bruce, Allan C. Rearick, Edward E. Stowell, Frank H. Cole, New York, and John J. Daly, Brooklyn.

SYRACUSE.—The Oswego River Power Transmission Company, of Syracuse, has been incorporated, to supply gas and electricity for power, light and heat in the counties of Onondaga and Oswego in particular, with the privilege of operating all through the State; capital, $20,000. Directors: Simon B. Storer, Louis W. Emerich and Geo. W. Pulver, of Syracuse.

MALONE.—The Malone Light & Power Company has under consideration a proposition for installing a complete duplicate plant at its works one mile north of here. The present plant is on the west side of the river, and the new one will be on the east side, directly opposite. Plans are now being made for the new equipment, and bids have been asked for machinery and supplies.

ALBANY.—The Hanover Light & Power Company, of Albany, has been incorporated with a capital of $2,000,000 to furnish gas and electricity for light, heat and power in Albany, Buffalo, Utica, Syracuse, Rochester, Troy and other cities in New York State. The incorporators are Edmund G. DuMazuel, Fred K. Morris, of New York, and Wm. Brower and Maurice S. Decker, of East Orange, N. J., and others.

BUFFALO.—The Western Counties Transmission Company, of Buffalo, has been incorporated; capital, $2,000,000. Directors: Robt. W. Pomeroy, Jos. G. Dudley, Harry T. Ramsdell and others. This company is to cover the counties of Erie, Niagara, Chautauqua, Cattaraugus, Genesee, Orleans, Wyoming, Allegheny, Monroe, Livingston, Ontario, Wayne, Yates, Schuyler, Chemung, Cayuga, Tompkins, Tioga, Oswego, Seneca, Onondaga, Cortland, Broome, Oneida, Madison, Chenango and Herkimer.

NORTH CAROLINA.

WAYNESVILLE.—The citizens have voted to install a system of electric lighting.

WASHINGTON.—The citizens here voted $15,000 additional bonds for an electric light plant for the city.

FAYETTEVILLE.—The Fayetteville Gas & Electric Company has been sold to J. H. Martin, of New York.

KINGS MOUNTAIN.—The citizens have voted to issue $15,000 bonds for the construction of an electric light plant.

WILMINGTON.—Bids will be received until June 8 by A. M. Waddell, Mayor, for lighting the city with gas and electricity.

MT. GILEAD.—The Mt. Gilead Telephone & Electric Light Company has been chartered by J. R. Blair and others; capital, $25,000.

WINSTON.—An election has just been carried for bonds at Winston in the interest of the interurban electric railway for which $37,000 was voted.

MOREHEAD CITY.—It is reported that the question of installing an electric light plant in connection with a water supply for fire protection is under consideration.

OXFORD.—A charter has been issued to the Oxford Water & Electric Company with $50,000 capital, for the purpose of constructing waterworks and an electric light plant for this town. The incorporators are Harry L. Millner, of Morgantown; W. T. Sherman, of Washington, D. C.

FAYETTEVILLE.—The Cape Fear Electric Power Company has offered to buy the city electric light plant and all other appliances, subject to a mortgage of $15,000 in bonds running from 1902 to 1932. To meet them, the company guarantees to pay $750 interest annually, and to set aside such a sinking fund as will meet the bonds at maturity. The company engages to furnish 51 arc lights of 1200 candle power, the city having the option of increasing this number when desired.

CHARLOTTE.—It is reported that all of the numerous water powers on the Catawba River, where thousands of horse-power are available and several already developed, are to be consolidated. Dr. Gil Wylie, of New York, and president of the Catawba Power Company, of Fort Mill and Charlotte, is at the head of the interests concerned in the rumored developments. The Catawba people have recently secured control of a valuable power near Camden, S. C., for something like $125,000.

GREENSBORO.—Mr. R. H. Gamwell is general manager of the Greensboro Electric Company, and we learn that the Greensboro Railway & Light Company has been chartered by the Secretary of State with $750,000 authorized capital for the purpose of purchasing, constructing and operating street railways and light plants, the subscribers to the stock being F. R. Williamson, of Flemington, N. J.; R. H. Gamwell, of Greensboro; W. M. Wherry, Jr., and W. A. Morgan, of New York, and W. W. Gamwell, of Pittsfield, Mass.

NORTH DAKOTA.

ENDERLIN.—C. C. Dalrymple is stated to have secured a franchise for an electric plant.

WILLISTON.—The citizens have voted to construct an electric light plant and install a system of water works.

RUGBY.—A. H. Jones is said to have secured a franchise for an electric light plant and a telephone system.

OHIO.

SIDNEY.—A franchise has been granted to the New Bremen Electric Light Company to light the streets of this city.

HENO.—The Middletown Electric Light & Power Company has received the contract to light the streets of this city.

McCOMB.—The electric light plant has been purchased by this town for $5,000. Bonds will be issued to pay for the same.

WARREN.—Plans are being made to greatly enlarge the plant of the Youngstown Gas & Electric Company on North Avenue.

BELLEFONTAINE.—Bellefontaine has voted

in favor of issuing $50,000 bonds for improving the municipal electric light plant.

CLEVELAND.—The People's Electric Light & Power Company is reported incorporated with a capital of $10,000 by H. I. Emerson, W. McBride, D. F. Crane and others.

LOVELAND.—The Loveland Citizens' Electric Company has been incorporated with $100,000 capital stock by H. C. Hubbell, C. B. Vandervort, Joseph Baeth, H. S. Tunneson and H. C. Ramsey.

NORWALK.—The Board of Public Service is reported to have granted to the Cleveland & Southwestern Traction Company (E. F. Schneider, purchasing agent, Cleveland) a franchise to light Norwalk.

COLUMBUS.—The Columbus Public Service Company will increase its capital an additional $250,000 to be used in enlarging the plant at 17th and Mound Streets and in extending the hot-water system into sections on the East Side.

BARNESVILLE.—The contract for lighting the village by electricity has been awarded to the Barnesville Gas & Electric Company, of Barnesville, at $75 per light per year for arc lights, and $19 per light per year for incandescents.

SPRINGFIELD.—The Springfield Light & Power Company, which was owned by the American Railways Company, of Philadelphia, has been bought by the People's Light, Heat & Power Company, of this city. The new concern is a combination of all the public service companies and is said to be incorporated for $2,000,000. Among the incorporators are: F. M. Hagan, Walter L. Weaver and John F. Zimmerman.

HAMILTON.—The Hamilton Gas & Electric Company will expend about $500,00 in improving the plants recently acquired through a merger of the Hamilton-Otto Coke Company, the Hamilton Electric Light Company, and the Hamilton Gas & Coke Company. The improvements will include a new electric plant, new overhead construction for electric service and general enlargement of the three plants.

ELYRIA.—The stockholders of the Ford Light & Heating Company have organized by electing the following named officers: J. C. Hill, president; E. A. Berry, vice-president; L. B. Fauver, secretary; J. C. Smith, treasurer; E. E. Martin, assistant treasurer. The company will move its plant to Elyria from Garretsville, where it was formerly known as the Ford Lighting Company. The capital stock has been increased from $25,000 to $50,000.

CINCINNATI.—The Cincinnati Gas & Electric Company, at its annual meeting, arranged for large expenditures on new gas and electric light development. The report of President Keenan showed a gain for the year of 1,169 consumers of electricity. During the year nineteen isolated electric light plants were shut down in order to change over to the company's service. Two-thirds of the entire voting stock was represented and resulted in the election of the following board of directors: Stephen R. Burton, J. T. Carew, Briggs Cunningham, R. A. Holden, J. B. Foraker, Jr., A. H. Hinkle, Norman Kenan, M. E. Moch, W. Cooper Procter, C. H. Rowe, J. G. Schmidlapp, W. S. Rowe, M. M. White and Casimir L. Werk.

OKLAHOMA TERRITORY.

GUTHRIE.—The Guthrie Electric Light & Power Company, of which Thomas H. Smith is president, will enlarge its plant in the near future.

McLOUD.—The business men of this city are considering the proposition of several promoters to put in an electric light plant. S. J. Williams is said to be among those interested in the project.

OREGON.

HARRISBURG.—The City Council is reported to have decided to issue bonds for water works and an electric light plant.

IONE.—It has been decided to issue bonds to cover the cost of a municipal electric lighting plant, which will be installed immediately.

CASTLE ROCK.—A franchise has been granted to the Kalama Light & Power Company allowing it to furnish electric light and power.

PRAIRIE GROVE.—C. L. Cummings & Son are ready to receive bids for the construction of an electric light plant to cost from $2000 to $3000.

BAKER CITY.—The Baker Light & Power Company has been incorporated with a capital stock of $400,000, by C. A. Johns, F. N. Averill and J. H. Parker. This corporation takes over the Rock Creek Power Company and the Baker City Gas & Electric Company.

WASCO.—W. M. Barnett, of Wasco, president and manager of the Wasco Milling Company, writes that it is proposed to construct an electric light and power plant to cost from $35,000 to $40,000. Engineer A. M. Mohr, The Dalles. The plant will be located about thirteen miles east of Wasco on John Day River.

LA GRANDE.—The Grande Ronde Electric Company and the La Grande Storage Water Company have consolidated. The directors of the company are J. A. Thronsen, Walter M. Pierce, W. G. Hunter and T. H. Crawford. Power on the Cove line will be developed first. The Grande Ronde Company gets power from Cove and the La Grande Company from Morgan Lake.

SALEM.—The management of the Citizens' Light & Traction Company, of this city, is making preparations for the proposed electric road from Salem to Portland, Ore. Manager A. Welch announces that plans are being perfected for the establishment of a power-generating plant on the upper Santiam, with a minimum capacity of 15,000 horse-power. The cost of installation for the transmission of power to Salem will be not less than $300,000.

PENNSYLVANIA.

ALLENTOWN.—The Merchants' Light & Power Company has petitioned the Council for a light and power franchise.

YORK HAVEN.—The York Haven Water & Power Company has decided to extend its lines to Lancaster County and in Dauphin County.

SCRANTON.—An ordinance has been introduced in the Council granting a franchise to the West Scranton Light Heat & Power Company.

KENNETT SQUARE.—Bids have been advertised by the Borough Council for lighting the streets, hall and fire engine house in this borough.

READING.—Judge Hassler at Lancaster has awarded control of the Lancaster Electric Light Heat & Power Company to a Philadelphia syndicate, headed by Clarence H. Burr, to reorganize the concern.

MAYTOWN.—This village has contracted to have its streets illuminated by electric lights.

COLUMBIA.—The Council is reported to have passed an ordinance granting a franchise to the Columbia Light & Power Company.

TOWER CITY.—H. T. Bressler has completed arrangements for the erection of a new electric plan to provide lights for this city, Williamstown, Lykens, Wiconisco, Rinerton and Johnstown. The plant will be located here.

SHENANDOAH.—The directors of the Citizens' Electric Light Company have elected officers as follows: president, William Krick; vice-president, W. H. Waters; secretary, J. W. Daddow; superintendent and treasurer, T. F. Bradigan.

FORT WASHINGTON.—Harvey S. Souder and Samuel S. Alderfer, both of Souderton, and others are about to petition the Governor for a charter for the Wissahickon Electric Company, to supply light, heat and power in Whitemarsh Township.

FRACKVILLE.—The Frackville & Gilberton Light, Heat & Power Company has elected as directors W. C. Wagner, John Dunlap, Samuel Bailey, Orval Miller, Garrett Keating, Thomas Lafferty, David Taggart, C. A. Blieler and G. W. Johnson. The officers are: President, David Taggart; secretary, C. A. Blieler; treasurer, L. C. Anstock.

PHILLIPSBURG.—The Phillipsburg Electric Light Company will spend $40,000 in making improvements. New engine and new machinery have been ordered. These will be placed in the power house of the Centre & Clearfield Street Railway Company, whose large boilers will be utilized to furnish the power. The company proposes also to furnish the power for lighting Osceola.

MONONGAHELA.—The option given the Pennsylvania Railroad Company on the property of the Monongahela Electric Light Company and the property formerly occupied by the Monongahela Milling Company at Monongahela has been taken up and it is probable the transaction will be closed at once. Examination of the titles to the properties is being made now, after which the railroad company will take formal possession.

PITTSBURG.—The contract for the electrical construction work and apparatus for the filtration plant being contruction at Aspinwall has been awarded to the Morganstern-Ochiltree Company, of Pittsburg. It includes the installation of a complete power and lighting system, telephone exchange, police and time-clock systems. All the power, lighting and telephone cables will be placed underground, the conduits to include cables sufficient for supplying about 20,000 lights.

WILKESBARRE.—The directors of the Wyoming Valley Gas & Electric Company at a meeting here May 11 approved of work already under way, also recommending an additional expenditure for equipment of power houses and for other machinery. They authorized an expenditure of $75,000 for new gas making machinery and laying new pipe. Ambrose West, of Plymouth; C. H. Gist, of Philadelphia, and W. H. Anderson, of Grand Rapids, Mich., are reported to be among the directors.

YORK.—Charles H. Baer, president of the Merchants' Electric Light, Heat & Power Company, closed a contract with Ephraim Hugentugler, assistant custodian of the York Post Office building, for supplying that structure with current for lighting and power for a period of a year. One year ago the Edison Light Company entered upon the contract to supply the Federal building with current, that corporation being the lowest bidder at that time, but the bid recently submitted by the Merchants' Company against the Edison Company's bid was lower still and the contract was awarded accordingly.

SELINGSGROVE.—Bids will be received June 1 by George W. Agenseller, secretary Middlecreek Electric Company, Middleburg, for constructing a complete water power electric plant, on Middlecreek, two miles south of Selingsgrove, for supplying light, heat and power to Selingsgrove, Sunbury, Northumberland, and perhaps to Middleburg, to consists of a dam across a ravine, about 360 ft.; spillway of dam to be 150 ft. long, dam to be 17 ft. high above water as per print; a tunnel and excavation 1255 ft. long through mountain for head race; two units consisting of four wheels, direct connected to two generators, switchboards, power house and 25 or 30 miles of line construction.

YORK.—The Hillside Water & Power Company and the Susquehanna Water & Power Company have been merged into McCall's Ferry Water & Power Company. The merger is taken to mean that an electric power plant will be installed at McCall's Ferry in the near future. These two companies, while chartered at nominal figures, have invested thousands of dollars in land adjoining the river shores. They have secured every tract of land for miles up and down the river and have hundreds and thousands of dollars tied up until a plant is built and power is being furnished to the large cities. It is stated that New York capitalists are interested. The location of the plant will make it possible to supply current to Baltimore, Wilmington, York, Havre de Grace and Philadelphia.

RHODE ISLAND.

CENTRAL FALLS.—This city, which is supplied with light by the Pawtucket Electric Company, is determined to own its own lighting plant. The present contract with the Pawtucket concern will not expire for five years, but the City Council has already secured an option on a site, and at its next meeting will probably make an appropriation for a suitable structure.

SOUTH CAROLINA.

ORANGEBURG.—The commissioners of public works of Orangeburg have been instructed to se-

cure information as to the best machinery, etc., for improving the lighting system. About $5,000 is to be expended.

COLUMBIA.—The Columbia Electric Street Railway Light & Power Company is to acquire by purchase the Columbia Water Power Company. Mr. F. S. Anable, of Boston, and Mr. Francis K. Carey, of Baltimore, are interested. An auxiliary steam plant costing $300,000 is to be erected to be used in emergencies and the company is to supply motive power to the factories, mills, railway and other plants here.

SOUTH DAKOTA.

VERMILLION.—The citizens have voted in favor of municipal ownership of the electric light plant.

BERESFORD.—A. O. Hanson has purchased the mill and electric light business of M. M. Doyle & Son.

DEADWOOD.—The Lead and Deadwood Electric Light Companies are reported to have been consolidated and will expend about $1,000,000 in the installation of new machinery and building transmission lines; a power plant will also be constructed at Pluma. N. E. Franklin, of Deadwood, is reported interested.

TENNESSEE.

OLIVER SPRINGS.—It is said that Rich Brothers will install an electric-light plant here.

BOLIVAR.—It is proposed to petition the State Legislature for permission to issue $20,000 bonds for water works and an electric light plant.

HARRIMAN.—H. A. Coles, of Atlanta, Ga., has prepared estimates for a new electric light plant for Harriman. He estimates the cost at $40,000.

DRESDEN.—The State Senate is reported to have passed a bill authorizing this city to issue $10,000 bonds for water works and an electric light plant.

CLARKSVILLE.—The Clarksville Street Railway Company has purchased the plant of the Queen City Electric Light & Power Company; extensive improvements will be made.

NASHVILLE.—A bill has been introduced in the Tennessee Legislature providing for a tax of $1,000 on electric light plants of 1,000 lights or over, and $2,500 in cities of 100,000 inhabitants or more.

MEMPHIS.—A committee has been appointed by Mayor Williams to secure information as to cost, etc., of an electric light plant, to be owned and operated by the city at a probable cost of $1,000,000.

KNOXVILLE.—James B. Cahoon, Consulting Engineer, 42 Broadway, New York, N. Y., writes that only preliminary work has yet been done on the proposed plant of the Knoxville Power Company; probable cost of work complete, $2,790,000.

SHELBYVILLE.—Bids will be received by the Light Commission at Shelbyville, Tenn., until June 6 for furnishing twenty or more 2,000-c.p. enclosed arc lamps for street lighting purposes, the prices to be based on a ten-year contract with a franchise for commercial lighting at prices to be proposed by the bidder.

TEXAS.

BRYAN.—The building and operating of an electric light plant here is considered favorably by the committee of aldermen, who were appointed to look into the matter.

MARBLE FALLS.—M. H. Reed is interested in the construction of an electric light and power plant to be constructed here at a cost of $160,000. No engineer has been chosen yet.

GAINESVILLE.—The Gainesville Electric Railway & Light Company, recently incorporated with a capital of $50,000, is preparing to begin active work on its proposed power plant. The company has also been granted a franchise to build and operate a system of electric railways in Gainesville.

CLARKSVILLE.—The Clarksville Light & Power Company has been sold to the Clarksville Light Company, a new concern, composed of D. W. Cheatham, president; B. A. Dinwiddie, vice-president; John W. O'Neill, secretary, and A. M. Graves. The company has also purchased machinery for an ice plant, which it will run in connection with the light plant.

UTAH.

EPHRAIM.—The citizens have voted to construct an electric light plant at a cost of $20,000. Jas. Frost is City Recorder.

COALVILLE.—An election will probably soon be held to vote on issuing $10,000 bonds for the construction of an electric light plant.

OGDEN.—A company will shortly be organized here to establish an electric lighting plant, $30,000 having already been subscribed for the purpose.

SALT LAKE CITY.—The Cramer Electric Company of this city, with a capital of $50,000, has been incorporated. Lee Cramer is president.

SALT LAKE CITY.—Wm. A. Clark, of Salt Lake City, has made application to the State Engineer to appropriate 300-second feet of water from Blacksmiths Fork River for the development of power. It is expected that 2,000 horse-power will be generated, most of which will have to be transmitted for a distance of about sixty miles; total cost of plant and lines will be about $75,000.

VERMONT.

BENNINGTON.—The Bennington Electric Company has taken over the Bennington Water & Light Company.

MONTPELIER.—Mr. J. E. Davidson, who has been connected with the Port Huron (Mich.) Power & Light Company for the past six years as secretary, has resigned that position to accept a similar one with the Consolidated Light & Power Company, of Montpelier, Vt. The latter company has been transferred to Wilbur F. Davison, A. D. Bennett, George Moore, of Port Huron, Mich., and some Eastern associates. The sale was made on a cash basis for about $200,000. The company's system extends from Bolton Falls, 12 miles below this city, to the granite quarries in Barre. It supplies municipal lights for Montpelier and Barre, besides a large number of private lights, and furnishes power for the electric railway and several granite plants. The property has been in the hands of the National Life Insurance Company for some years.

VIRGINIA.

ASHLAND.—It is reported that the Virginia Passenger & Power Company has received the contract for lighting this town with electricity.

RICHMOND.—E. W. Trafford, recently appointed by the city to report on the matter of a municipal electric light plant, is stated to have completed his report and estimates the cost of a plant at $400,000. Mr. Dabney, Chairman Lighting Committee.

WASHINGTON.

UNIONTOWN.—M. J. Shields, of Moscow, Idaho, has petitioned for a franchise for an electric light plant.

SEATTLE.—The Seattle Electric Company is considering the extension of its system to the northeastern part of city.

SEATTLE.—The Mutual Light & Heat Company, of this city, has gone into new hands. N. H. Latimer is now the president.

BELLINGHAM.—The City Council will establish an electric light plant in connection with the pumping plant on Sehome Hill.

PALOUSE.—Reports state that the Palouse Light & Power Company will install a new 260-h.p. compound condensing engine in its power plant about July 1.

SUMAS.—Franchises have been granted to the Sumas Electric Light, Water & Power Company. Work upon the plant is to commence at an early date and it will cost $20,000.

KENNEWICK.—C. E. Wood, of Genesee, Idaho, offers to put in an electric light system and a flour mill here at once if he can secure a franchise for the electric light system.

GOLDENDALE.—H. W. Fellows, of Spokane, is interested in the construction of an electric light plant at Goldendale, to cost about $50,000. Power is to be developed from the falls of the Little Klickitat.

PROSSER.—President E. F. Benson, of the Prosser Falls Land & Power Company, has filed a notice at the office of the county auditor of the appropriation of 5,000 cubic feet of water per second from the Columbia River, to be diverted at Priest Rapids, for the purpose of generating electric power at that point and transmitting the same to Prosser.

WEST VIRGINIA.

MARLINTON.—The Marlinton Light & Water Company proposes constructing water works and an electric light plant here.

WELCH.—The Citizens' Light & Water Company, of Welch, has been incorporated by the Secretary of State. Capital stock, $25,000. Incorporators: W. Burbridge Payne, James A. Strather, Edgar P. Rucker, I. J. Rhodes, M. W. Hutson, Louis Morse, C. D. Brewster, A. Q. Letz, L. Masil, Welch, W. Va.

WISCONSIN.

SPRING VALLEY.—The Council is reported to have granted R. D. Harrison a franchise for an electric light plant.

GREEN BAY.—The Green Bay Gas & Electric Company has been formed, capital $750,000. Incorporators: William Mainland, Ralph M. Burtis and Sinclair Mainland.

BURLINGTON.—In regard to the construction of an electric light plant, for which the citizens recently voted to issue $8,000 bonds, the Council is taking steps to construct a plant with a capacity of fifty 2,000 candle-power arc lamps.

WAUWATOSA.—The County Board of Supervisors, at a meeting at Milwaukee, May 9, is stated to have passed a resolution providing for the appropriation of $100 to be used to prepare plans for the installation of a general light and heating plant and a pumping station for the county institutions at Wauwatosa.

LA CROSSE.—The Wisconsin Light & Power Company, of La Crosse, has placed orders with the Westinghouse Companies covering the entire equipment of a large light and power plant. Besides two alternating-current generators with an output of 400 kilowatts each, which will be driven by steam turbines, there are three vertical steam engines, one of which will be connected to a 25-k.w. direct-current generator. In addition, there will be installed two motor-generator sets, each consisting of a 7½-k.w. direct-current generator and a 15-h.p. induction motor, three 10-k.w. and three 15-k.w. transformers, one 6,600-volt 10-panel switchboard and one 220-volt arc-lamp panel, fifteen low-equivalent lighting arresters and choke coils, and 25,000 incandescent lamps with Edison bases.

CANADA.

OXFORD.—The electric light plant and many business places were totally destroyed by a recent fire.

NIAGARA FALLS, ONT.—The Ontario Power Company has awarded a contract to the Archbold-Brady Company, of Syracuse, N. Y., for the construction and erection of 200 steel towers for the double transmission line from the company's plant at Niagara Falls down the river and across to the American side, a distance of about six miles. The contract amounts to $50,000.

OTTAWA, ONT.—An important epoch in electrical development in Ontario has been marked by the action of the Railway Committee of the Provincial Legislature. A Government clause has been inserted in a bill retaining to the Government the right to transmit electricity from water powers to the municipalities. This step probably foreshadows an advanced policy on the part of the Government for the development of water resources in the interests of municipalities. Public ownership of public utilities seems to be the object in view.

ST. JOHN, N. B.—United States capitalists who make up the Electrico-Manganese Company are depositing $50,000 with the New Brunswick Government as evidence of good faith that they will develop the great water power of Grand Falls on the St. John River. Their project includes establishment of ferro-manganese mills, the operation by electricity of a railway from Campbellton to a point near the Maine border and transmission of electricity down the St. John River Valley for lighting and manufacturing. The expenditure is estimated at from $3,000,000 to $4,000,000. In the company are Barton E. Kingman, of New York, and Frederick Sayles, of Providence.

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MODERN AUSTRIAN HYDRO-ELECTRIC GENERATING PLANT.

SOME FEATURES OF THE CENTRAL STATION IN ZWOLFMALGREIEN.

BY A. STEENS.

The conditions which had to be considered in the construction of the recently opened electric light and power plant at Zwölfmalgreien, a town near Bozen in the Tyrol, are of such a striking nature as to stamp the entire plant with a peculiar interest. The fundamental conception, dominating the entire undertaking, was that of combining an electric plant with water-works for the distribution of water for private consumption. Such a combination was in itself a guarantee for the cost of erection and running expenses, while promising highly favorable returns on the capital invested.

The town of Zwölfmalgreien had for a long time felt the need of a system for drinking-water distribution, as there were only three wells and a wooden aqueduct bringing water from the neighborhood of Bratenstein. The rising manufacturing interests of the place and the large and constantly growing number of tourists visiting it made a better domestic water service a necessity. The matter was investigated, and while studying it the requirements of the neighboring townships of Gries and Korneid were likewise taken into consideration. The committee in charge of the survey decided to harness the springs of the "Hals," in the Eggenthal, as well as those of the Ruselquelle and the Rameglerquelle, which furnish 50 litres of water per second, and to lay the water conduit through the Eggenthalerstrasse. But the committee was obliged to abandon the plan on account of the numerous difficulties encountered. A

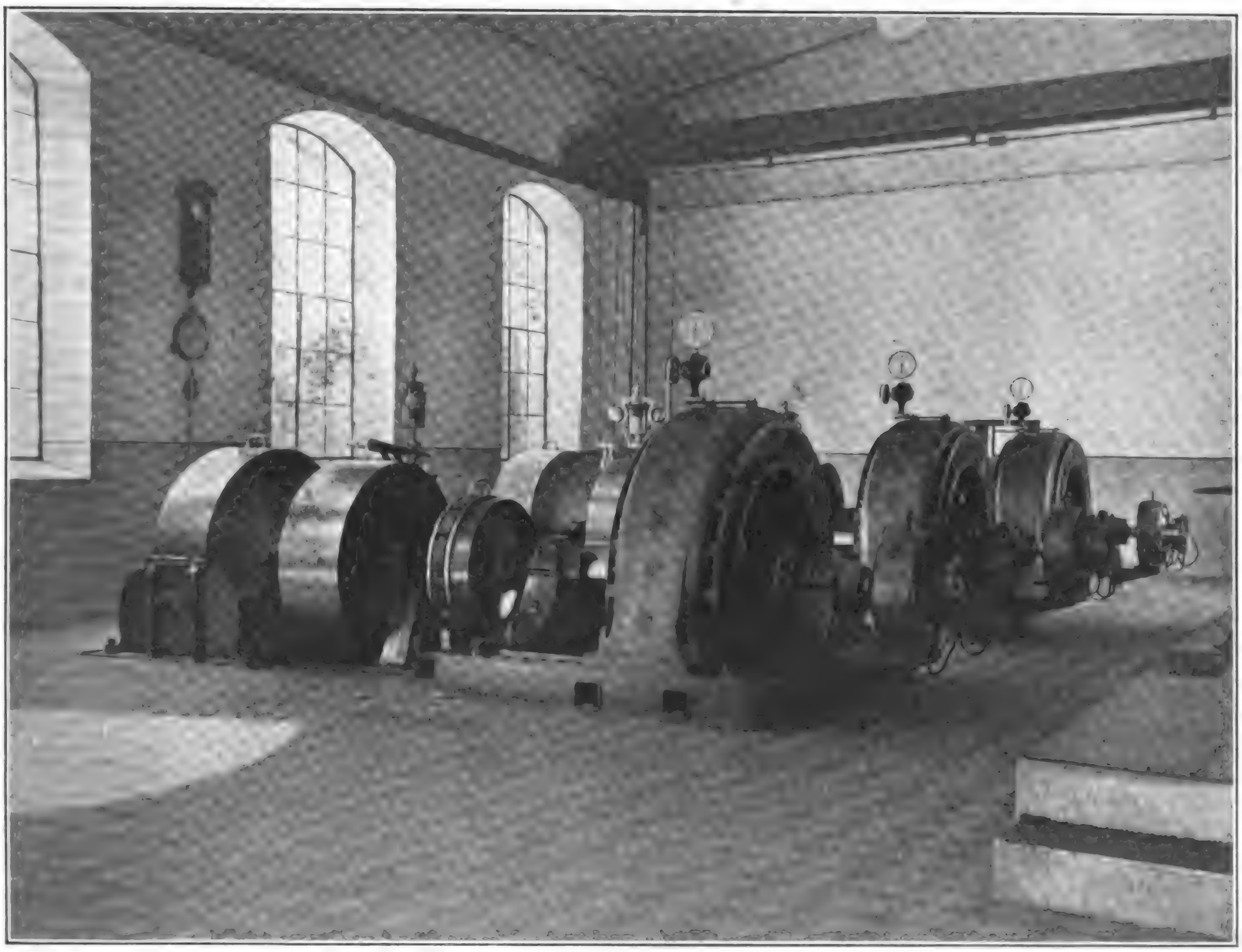


FIG. I.—INTERIOR VIEW OF THE HYDRO-ELECTRIC STATION AT ZWÖLFMALGREIEN,

choice of two alternatives was still left, one of which was an overhead pipe line suspended from the rocks and the building of an aqueduct, and the other the construction of an underground passageway or tunnel. The first alternative had to be abandoned on account of serious technical difficulties, and consequently the second plan, that of placing the supply conduits in an underground passageway or tunnel cut through the mountain, was resorted to.

In order to reduce the estimate for building a drinking-water supply system, the town decided to likewise carry out the plan which had been under consideration for a long time, viz.: the installation of an electric plant, and the use of the drinking-water supply tunnel for transmitting the hydraulic power which was to be supplied from the Eggenthalerbach. After an examination of the various plans, the one proposed by the Ateliers de Construction Oerlikon (Oerlikon Works) was adopted, and this firm was entrusted with the construction of the entire installation.

The hydraulic power is furnished by the Eggenthalerbach; this creek has its source at the foot of the Latemar group in the Dolomite mountain chain, is reinforced throughout its course by the waters from two other creeks, the Zangenbach and the Welschofenbach, and empties into the Eisack River near Kardaun. At their average height (220 millimetres) the flow of the waters of the Eggenthalerbach is about 2.32 metres. Gauge tests have shown that the minimum quantity of water was 600 litres per second. The terms of the contract allow of the taking of a maximum of 1000 litres of water per second from the creek.

The upper end of the water dam is 516.1 metres above the sea level, and 3.375 kilometres from the plant; it is constructed of masonry, with a total length of 60 metres and a width of 4.5 metres at the top, which latter is covered with boards which when damaged, may be easily replaced.

FIG. 2.—HYDRO-ELECTRIC STATION AT ZWÖLFMALGREIEN, SHOWING PIPE LINE.

The water flows through five openings at the intake proper, provided with gratings, each of which can be taken out separately, and is composed of gas pipes having a diameter of 50 millimetres.. The bottom of the collecting channel is made of concrete, and the side walls, which are partly built against the rocks, are constructed of masonry. The bottom of the collecting channel has been made lower than that of the main channel which it supplies for the purpose of preventing a part of the substances carried along by the water from being carried down into the tunnel, the result being that most of the rolling pebbles and other impurities carried along by the creek are deposited on the bottom of the collecting channel, whence they are from time to time removed by the opening of a sluice gate, which is 1 metre wide and 2.5 metres high and located in a prolongation of the collecting channel.

The passageway or tunnel, which is at a right angle to the collecting channel, is provided with a grating at the intake, the spaces between the bars of which are 15 millimetres. Two more sluice gates, 1 metre wide and 2.5 metres high, have been placed farther in the tunnel, and eight discharge sluice gates have been distributed along the entire length of the tunnel.

The tunnel runs for nearly its entire length through good rock (porphyry). Disintegrated rock has in a few isolated places been encountered, requiring at these points the construction of a lining of masonry. The water furnishing the motive power occupies a space of 1 sq. metre at the lower part of the tunnel, and a wooden flooring has been constructed above this flow of water, supported by the rails which were used during the boring of the tunnel. There is still a space of 1.6 metres above this flooring, so that it is possible to pass through the tunnel throughout its entire length. At the side of this flooring and supported by the same rails, is the drinking water conduit, with an inside diameter of 225 millimetres. The grade of the tunnel is 1.5 per thousand, and the water flows at a speed of 1 to 1.5 metres per second. At the lower end of the tunnel the water is discharged into a "water chamber" located at an altitude of 551 metres above the sea-level. This "water chamber," which is constructed entirely of concrete, is not intended to serve as a reservoir, but merely as an intermediary station between the supply tunnel and the hydraulic pressure pipe, which is the final water container. In order to remove the impurities which settle at the bottom of the "water chamber," a discharge sluice gate has been constructed at one of its sides. The entrance to the hydraulic pressure pipe is opposite the tunnel outlet, which latter may be closed by means of a gate. The pressure pipe has an air outlet located at the intake, which outlet allows the air to escape when the pipe is filled under pressure.

The pipe is constructed entirely of steel

FIG. 3.—TRANSFORMER TURRET.

plate; it is 416.4 metres in length, and at 11 different places along its length the thicknesses of the pipe walls are progressively increased, so that while the steel plates measure only 5 millimetres at the top, they have a thickness of 15 millimetres in the last section, at the lower end. The inside diameter of the pipe is 900 millimetres and each length is 6 metres; the longitudinal seams are fastened by two rows of rivets, with a single row for joining the ends. The flanges, with the exception of those of the lowest part (which are of cast steel), are of forged iron. The pipe, at regular intervals, rests free on cast-iron supports, solidly fastened to concrete blocks. Care has been taken to solidly anchor the conduit at the four bends which occur along its entire length; it is, furthermore, provided with expansion joints at three places and it terminates at the lower end in a trench 33 metres long, cut out of the mountain rock immediately alongside the walls of the power plant. The gross fall that may be used for power purposes (measured down to the turbine shaft), is 210 metres, while the net fall is 208 metres. The maximum speed of the water is 1.42 metres per second; this maximum speed is obtained when all the power at hand (2000 horsepower) is used, or, in other words, when all four turbines are in operation.

The central power house is located at the entrance of the Eggen valley, near Kardaun, at the place called Florkeller, on the left bank of the creek known as the Eggenthalerbach, and at an altitude of 300 metres above sea-level. It is located about 700 metres up-stream above the mouth of the last named creek, where it flows into the Eisack river and is about 4 kilometres from the Bozen railway station.

The plant comprises a main building with an area of 374.5 sq. metres and contains the large dynamo room (275 sq. metres). There is, moreover, an annex, a two-story building, the lower floor of which is occupied as an instrument room (25.4 sq. metres), while the second story is used as an office. The repair shop has been located in the basement on the side toward the creek, covering an area of 29.55 sq. metres. A staircase connects the dynamo room with the office. The wall of the latter nearest the dynamo room has a large window, allowing a full view of the machinery from the second story. The repair shop is likewise directly connected with the dynamo room by means of a staircase. The building has concrete floor and walls of masonry

FIG. 4.—SWITCH HOUSE FOR CHANGING FROM UNDERGROUND TO OVERHEAD DISTRIBUTION.

(porphyry). The roof is supported by an iron framing to which a wire netting is fastened, holding the inner plastering. The floor of the dynamo room is covered with cement slabs. A platform has been erected in front of the switchboard, at a height of 400 millimetres above the floor of the dynamo room. This platform is constructed of a block of cement, covered with linoleum, and a rubber matting is provided to insure perfect insulation. The floor of the apparatus room is of concrete and likewise covered with rubber matting. A traveling crane of 7.5 tons capacity is installed in the dynamo room, capable of handling any one of the five hydro-electric units. As soon as the installation shall have been entirely completed there will be four hydro-electric units in active service, while a fifth will be held in reserve.

The works are lighted by three 15-ampere arc lights, connected in series; 8 incandescent lamps fastened on brackets in groups of two, and two additional incandescent lamps for lighting the switchboard. In addition to the above, kerosene lamps have been furnished for use, should the electric current fail. The instrument room is lighted by two incandescent lamps.

The ditch for the water supply conduit is outside, and runs along the southern frontage of the building. This ditch, which extends the entire length of the building, is lined with concrete and is two metres wide, with a depth of 1.7 metres.

The turbines, as well as the hydraulic pressure piping, the iron parts of the water intake and of the water chamber, were furnished by J. Ig. Rusch. of Dornzirn, Voralberg, Austria. The lower part of the hydraulic service pipe in the above-mentioned ditch contains the water distributing device and the five conical outlets for conveying the water to the turbines. Each of these outlets is provided with a high pressure slide-valve, and in front of the first there is an air chamber. The distributing device is provided with four safety valves and a cleaning-out valve at the lower end. The latter has a bell-shaped protector for the purpose of sufficiently diminishing the water velocity to prevent damage to the concrete lining of the ditch.

The turbines are constructed for a net fall of 208 metres. They use 226 litres of water per second and produce 500 horse-power when running at the rate of 500 r.p.m., which corresponds to 80 per cent of the full power guaranteed by the builder. They are of the Rusch "spoon" type of construction.

After passing through a controlling valve the water enters the turbine chamber and from there passes to the distributor, which consists of phosphor-bronze troughs. Each trough may be separately closed by a cog crown wheel valve, which is likewise constructed of phosphor-bronze. This valve is controlled by means of a hand wheel placed on the platform in front of the switchboard. The spoons or buckets of the turbine wheel are of white metal and may easily be replaced when damaged. The controlling valve in front of the turbine chamber, which automatically regulates the inflow of the water, is moved by an hydraulic relay operated by a very sensitive ball governor.

FIG. 5—TRANSFORMER TURRET FOR HIGH-TENSION CURRENT.

The water required for operating the hydraulic relay is taken from the service pipe and passes through a double filter before reaching the relay. Any jerky operation of the governor is slowed down by an oil regulator, and further regulation is secured by safety valves connected with the above-mentioned distributing device, placed alongside of a 3250-kilogram fly-wheel, 1450 millimetres in diameter. As soon as the water pressure rises above the normal point these safety valves allow a certain quantity of water to escape. An air chamber placed in the front part of the first neck of the distributing device prevents water hammering.

Direct-driven speed gauges from the dynamo shafts are provided for noting the generator speeds. According to the builder's guarantee, whenever sudden changes in the load take place amounting to as much as 50 per cent the speed variations must not exceed 3 per cent, more or less, and for load changes amounting to 100 per cent the speed must show a minimum variation of 6 per cent, more or less. Tests have been made for the purpose of determining the regulating quality of the apparatus. The load was varied by the use of water resistances, and the tests showed that when suddenly changing from a load of 380 horse-power to no load the speed of the turbine varied only 2½ per cent from that which it made with a 380-h.p. load. A comparison between a turbine running without a load at full head and a turbine running with a full load could be easily and safely made.

The generators, which have a capacity of 500 horse-power each, were furnished by the Oerlikon Works. At a speed of 500 revolutions per minute they produce a 3600-volt, three-phase current of 50 cycles. The power factor is 0.8. The generators are coupled to the turbines through elastic coupling flanges.

The armature space measures 1400 millimetres. The armature, which has 72 slots, is provided with 18 coils, each of which is composed of 17 two-wire windings of a diameter of 04.0 to 04.6 millimetres. These coils are wound to gauge. The diameter of the rotor is 1390 millimetres. The 12 conductor coils which are connected in series are each composed of forty 3x33-millimetre, copper-tape windings for the field. The different windings are insulated from each other by means of a 0.5-millimetre asbestos layer.

The exciters are keyed direct to the generator shafts and produce a current of 200 amperes. They are provided with 12 carbon brushes, 24 by 16 millimetres in size.

The conductors connecting the generators and the exciters with the switchboard are for a part of their total length enclosed in a conduit sunk in the floor of the dynamo room and covered with sheet iron. On leaving the conduit they run through a channel in the basement. The main conductors are fastened to double-petticoat, porcelain insulators on iron supports. The conductors for the exciting current are fastened to small cylindrical insulators.

The controlling apparatus, fuses, bus-bars, etc., are placed in a room separated from the dynamo room by the switchboard, which is constructed of white marble panels enclosed in a channel iron frame. Below the marble slabs the partition is constructed of perforated sheet iron, which allows of a continuous ventilation for the switchboard.

Of the five panels which make up the board, the first three, counting from the left, are for the three generators already installed. Each slab is provided with an ammeter for measuring the primary current of the generator, another ammeter for the exciting current, the handle for the three-pole circuit-breaker and the hand-wheel for the regulator.

There being two bus-bar systems, one for the light and the other for the power circuit, the fourth panel is provided with an ammeter and a voltmeter for each of the bus-bar systems. A common voltmeter with switch has been provided for measuring the phase tension of the different generators. All the voltmeters have been so mounted that they may be turned. The fourth panel has placed alongside of synchronizing lamps, the lever of a three-pole circuit-breaker, by means of which the two bus-bar systems may be connected in parallel.

The switchboard room is divided in two parts by an aisle enclosed on both sides by an insulated railing. On the side nearest to the dynamo room there are for each dynamo a three-pole circuit-breaker, three single-pole, high-tension fuse switches, the switchboard transformer with two fuses in the primary circuit and the regulating resistances.

In the opposite part have been placed aluminum bus-bars for the light service as well as those for the power service, each of these being provided with a fuse. Moreover, there is a three-pole switch for each generator, which arrangement permits of switching the generators either on the light or on the power circuit. In the same part of the switchboard room is placed a 7-kilovolt-ampere transformer furnishing the current for the lighting of the plant as well as for the neighboring dwellings.

Beyond the fuses the conductors run upwards through two holes in the ceiling until they reach the inside of the roof where the lightning arresters are placed, grounded by means of 6 millimetre copper wires. At the place where they pass through the partition the wires of the lighting and power circuits run through glass tubes.

The two high-voltage systems, that form the lighting circuit as well as the power circuit, are partly underground.

The overhead conductors, both for lighting and power, are composed of 3 semi-hard copper wires 7 millimetres in diameter, follow at the start the left bank of the Eggenthalerbach to Ganserhof, where there is a transformer. Here it passes over the creek and follows it bank to where it flows into the Eisack, which it crosses at this point, the distance between the supports on both banks being 45 metres. The overhead line, which is 800 metres in length, ends 90 metres farther on a turret. The weight of the copper used for the lines is 1700 kilograms and the number of poles is 26. These poles, made of larch wood, measure 15 metres in height and have a diameter of 18 to 26 centimetres at the top. They are planted in the earth to a depth of 16 to 18 metres.

Each pole is surmounted by a lightning arrester, grounded by means of a 6-millimetre copper wire, at the base of which is a 400 to 450-millimetre ground plate. In order to make sure that the lightning arresters will work even in case of a defect in one of the copper grounding wires, they have all been connected by means of a zinc-covered wire 4.5 millimetres in diameter.

The above mentioned turret is erected for the purpose of changing the overhead line into an underground one. It is square built, of masonry, and has a height of 6.75 metres. The sides of the inside square measures 1.9 metres, and the walls are 3500 millimetres thick. There is an iron frame in the inside, which supports the Thomson lightning arresters, the induction lightning arresters with their induction coil and the three single-pole, high voltage fuses for each circuit. In the lower part of the turret are the connecting parts for the cables.

The cables are paper insulated, lead enclosed and covered with two layers of ribbon steel and tarred jute. The lighting and the power cables are placed side by side in a bed of sand, and are covered with porphyry slabs under a 700 millimetre layer of earth. 5080.1 metres of 3x50 square millimetre cable are used, as well as 3288.4 metres 3x25 square millimetre and 1721.7 metres 3x15 square millimetre cable, making a total length of 10,090.2 metres of cable. For the underground system, moreover, 53 joint boxes and 26 connection boxes have been used.

The transformers have been placed in cylindrical turrets constructed of forged sheet iron, anchored in a concrete block. There are two sizes of turrets, viz.: Those from which the secondary conductors start out in the shape of overhead lines, and which measure 6 metres in height, and those from which run the secondary conduc-

FIG. 6.—INCANDESCENT LAMP POST AT GRIES.

FIG. 7.—OVERHEAD SECONDARY LINES AND STREET LAMP.

tors in the form of cables, which are only 4 metres high. According to the number of high voltage fuses which must be enclosed in the turrets, they have a diameter of either 1422 millimetres or 1600 millimetres. The frame supporting the apparatus is separately anchored in the concrete and is, furthermore, fastened to the turret wall by means of screws. Each turret has three doors, one of which leads to the transformers, the second to the high voltage apparatus and the third to the low voltage devices. The cables, which are provided with a connection box, enter the turret on the side where the high voltage apparatus is placed. Both the lighting and power cables leave the turret on the same side, where the high voltage fuses required for the line, as well as the tree-pole, high tension fuses for the transformers are likewise to be found. These latter are located between the high and low voltage sides. Whenever two transformers are found in the same turret, one has been placed above the other. All the transformers are grounded by a 6 millimetre copper conductor anchored at its base in a 500 by 500 millimetre ground plate. On the low voltage side, on a white marble slab are placed the three-pole circuit breakers for the low voltage system, as well as the fuses for the secondary transformer coils and for the secondary circuit. The same marble slab supports the circuit breakers for the public lighting service.

Transformers are provided for the lighting circuit only. The high voltage currents pass through the transformer turrets for the purpose of making it possible, in case of accident to the high voltage lighting system, to feed the transformers from the power system.

At Zwölfmalgreien there are seven 6 metre and two 4 metre, and at Fries three 4 metre turrets. Moreover, a room of the Hotel Stigel at Zwölfmalgreien, built of masonry, is used as a transforming station.

In only one of the several stations does the primary current enter through an overhead line. The transformers reduce the lighting current to a voltage of 150. All the motors of more than two horse-power have been switched on to transformers, which are gradually being installed in accordance with actual requirements. At present the transformers feeding the lighting circuit are twelve in number, representing a total of 137.5 kilowatts.

At those localities where the consumption of electricity is very large, and where the esthetic question is more important than the cost, underground conduits are being used. At other points the secondary conducts are strung overhead. The low voltage cables, as far as their construction and installation are concerned, are identical to those for high voltage.

3138 metres of cable have been laid, ranging in size from 3x50 square millimetres to 3x35, 3x20 down to 3x10 square millimetres. The overhead conducts are 5.6 and 7 millimetres in diameter. They are supported on porcelain double petticoat insulators, fastened to wooden poles of a height of 10 metres. These poles carry a four millimetre wire for the incandescent lamps supplied for the public lighting service, as well as two, or even four wires of the same size for the arc lights. All low voltage conductors are of semi-hard copper.

The poles are surmounted by a sheet iron cap and a point. All these points are connected by means of a 3.5 millimetre iron wire. At distances of 3 or 4 poles this wire is grounded through a conductor of the same metal and diameter, soldered to a zinced iron plate.

The arc lights for the public lighting circuit are supported on lamp posts or suspended from steel wires strung across the streets. These lamp posts are thicker at the bottom than at the top, made in one piece and provided with a pedestal, cast iron rosettes and a forged iron arm. The height of the lamp above the street level is 6 metres. The lamp uses 15 amperes and gives 800 candle-power. They are connected in series, in groups of 3 or 4.

All the incandescent lamps for the public lighting service are 32 candle-power. They are either fastened to the poles, to the houses, or (at Gries) to lamp posts. The supporting arms for the incandescent lamps are forged iron and 750 millimetres long. They are provided with a conical reflector and a protecting globe hermetically closed. The height of the lamps above the street level is 4 metres.

as well as for power purposes is paid for either in an annual sum for each lamp or each horse-power, or at the rate of consumption as indicated by the meter.

More or less important rebates are allowed when this last method of payment is chosen, which rebates vary according to the size of the installation. The various localities to be lighted have been classified to facilitate the figuring of prices in lump annual sums. An annual rental is paid for the use of the metre.

INDIVIDUAL VS. BELT DRIVE IN ELECTRICALLY OPERATED SHOPS.

BY PUTNAM A. BATES.

Very few shop managers will dispute the question or the desirability of driving their machinery by electricity, but when a canvass is made of all the machine shops and factories throughout the entire country, one cannot help but be impressed with the fact that the electrically driven shop is as yet greatly in the minority, and even in the establishments where the electric motor is used, the electric idea has not been carried anywhere near far enough to permit of the full advantages being received from this method of power transmission.

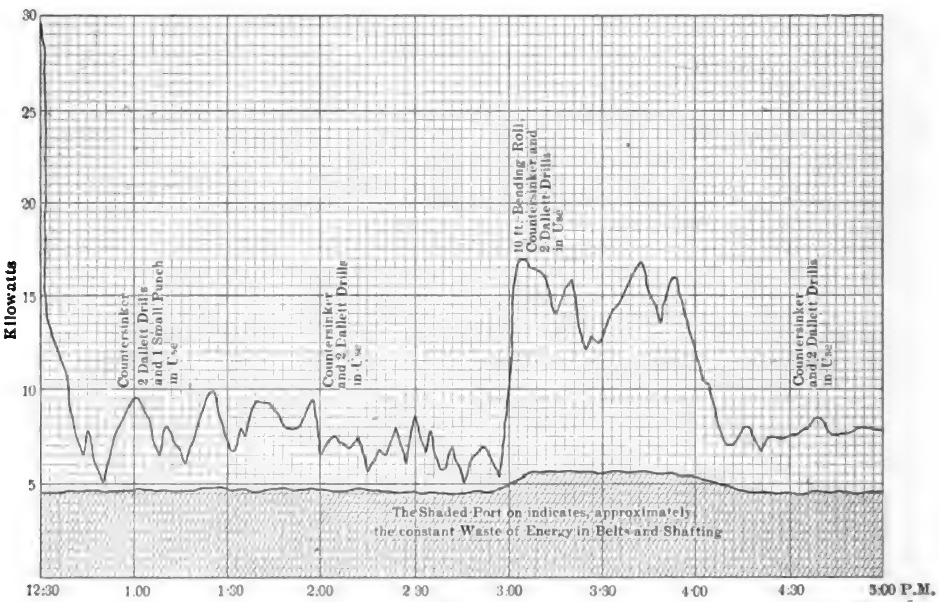


FIG. I.—LOAD DIAGRAM SHOWING POWER CONSUMED BY A 25-H.P. MOTOR IN BOILER SHOP.

As mentioned above, the circuit breakers and the fuses for the public lighting circuit are placed in the transformer turrets. At the present time 23 arc lights and 60 incandescent lamps have been installed at Zwölfmalgreien for the public lighting service. Gries has been supplied with 2 arc lights and 35 incandescent lamps (all installed on lamp posts). At the time the station was started 2000 lamps were used in the private lighting service, the lamps being 5 to 25 candle power.

The works employ, in addition to a general manager, a chief engineer, two engineers, a workman for the plant and a lineman, a box trimmer and a workman for the lighting circuit. The works are run day and night. The current for lighting

What is the reason for this condition? Is it that the electric motor has not yet demonstrated its worth for general power purposes? These are questions which naturally suggest themselves when one has occasion to visit a manufacturing establishment or machine shop where power is still transmitted by belting and shafting, rope drive or other mechanical means.

A consideration of these two questions and an analysis of the situation which suggests them may be at this time of some interest to those whose fortune or misfortune it is to have to utilize power in accomplishing the ends which they are daily striving for.

During the past fifteen years there has naturally been a great deal of progress and

improvement made in the methods of applying the electric motor to machinery, so that the energy which is transmitted electrically to the motor may be applied by the latter directly to the device by which the energy is to be utilized. There has also been a vast improvement in the construction of the electric motor itself, and owing to the large number of manufacturing concerns now making motors, the prices have been brought down by commercial competition to a point where the cost of electrical apparatus is within the reach of all.

In a number of the establishments where individual electric drive of machinery has been adopted, it has been demonstrated that the first cost of the electric motors and their accompanying controllers or starting boxes is no more than that for the equivalent shafting, hangers, belting and other paraphernalia plus the labor of properly setting them in place. In a new building, therefore, the installation of anything but individual electric drive, except possibly in some instance where peculiarly special conditions prevail, indicates a lack of familiarity with the full advantages which are to be derived from this method. In fact, if the average shop owner would only take the trouble to find out, he would discover that even in an old shop where power is being transmitted and applied indirectly by the usual mechanical methods, the actual saving to him in power consumed, and the advantages of increased rate of product output at lower cost which the direct electrical method makes possible, are many times more than sufficient to justify the bother and expense of the change.

It has been the writer's observation that in many instances where motors have been installed thorough consideration has not been given to the question of the correct size and type of motor for the actual conditions under which the machine which it will drive will be obliged to operate, the result being that the electrical equipment is either unnecessarily large and costly, or too small for the work, which means constant trouble with the motor and its controlling devices.

A very usual mistake which is so often committed in establishments where the electrical equipments have not been thoroughly laid out and planned before hand is illustrated by the following example: A section of a boiler shop contains, we will say, an edge planer, a heavy shears, three punches of different sizes and two plate bending rolls, one an 8-ft. and the other a 10-ft. bending roll. In this installation the edge planer and the shears, each of which is located somewhat distant from the other tools, have been equipped with individual motors. The remaining tools just mentioned, however, are located in a group together, and are all driven through shafting and belting by one 25-h.p. motor. . This motor is placed directly over the countershaft to which it is connected by a 14-inch belt. The countershaft pulley is about 30 inches in diameter and the distance between shaft centres about 7 feet. The countershaft is connected by a 24-in. belt to the main shaft, which is in turn located directly over the motor, thus giving two belt drives in a vertical plane.

From the main shaft the three punches are belt-driven directly, the largest punch being so located that there is no place for its belt to hang if removed from its driving pulley, hence the punch must be driven all the time whether doing work or not.

The two smaller punches are each driven by a quarter turn belt from the main shaft. The method employed for harnessing these two machines for their work may be described as that of "kicking" the belt off and "prying" it on with a "stick." Anyone who has seen this method used, especially in a case where "the belt sticks a bit," knows the time which is lost by the operator of the tool and the attendant of the next adjoining machine in "getting the thing started."

The two plate bending rolls are each belt-driven from a separate jack shaft placed directly over the rolls, and in turn belt-driven by the main shaft. In addition to the above the main shaft drives five portable drills and two countersinkers, all belt connected.

The appearance of this equipment is, as one may easily imagine, a mass of overhead construction put in every which way in order to support the shafting and belts, and without any apparent consideration of the valuable light and space which are thus shut off.

This is an example of a shop "electrically driven,' and yet how it does grate on an electrical man's nerves to see such a sight and hear of its being put in that class. To be sure it is electric drive, but what a pity it is that the electrical idea had not been thoroughly worked out and properly applied.

It may be interesting to discuss some of the details of this particular shop equipment.

FIG. 2.—SHOP IN WHICH THE ADVANTAGES OF ELECTRIC DRIVE HAVE ONLY BEEN PARTLY SECURED.

To demonstrate the saving in power consumption alone which can be accomplished by individually driving the machines, some tests were made on these motors installed in this boiler shop. These tests were made under normal conditions of operation.

A test of the 5-h.p. motor driving the shear by means of a belt running on the fly-wheel gave the following results:

Volts.	Amp.	Prob. HP.	Remarks.
230	21	5.85	Starting from rest.
230	4-5½	.86-1.2	Shear running free.
230	11-13	2.7-3.2	Cutting, ¼-in. iron full width of shear.
230	8	1.9	Cutting ½-in. iron 1¼-in. wide.

This tool is in use only at rather infrequent intervals, and being individually driven the motor is shut down at all times except when the shear is in operation, and therefore no power is uselessly consumed.

The motor driving this shear is placed on a bracket on the wall and is belted with seven feet between shaft centres to the fly-wheel of the shear, the diameter of the fly-wheel being 64½ inches. The connection between the motor and its tool is so bad in this case that in order to start the tool the operator must perform with his hand the duty of an idler pulley or else "the motor will not take hold of the belt," which is not an unnatural way for the motor to behave under the circumstances. A glance at the burned condition of the starter of this motor tells the story.

A test of the 10-h.p. motor, driving the edge planer by means of a countershaft and belts, gave the following results:

Volts.	Amp.	Prob. HP.	Remarks.
240	46	12.6	Starting from rest.
240	15	3.38	Planer running free.
240	35-40	9-10.3	1/16-in. cut from 9/16-in. iron plate.
240	30	7.7	Reverse of planer.
240	25-30	6.4-7.7	Normal cut from 9/16-in. plate.

This tool is in use for about one-half to two-thirds of the time, it being entirely shut down while the work is being shifted. As in the case of the shear this is possible because the tool is individually driven.

The test of the 25-h.p. motor which drives the several lines and countershafts in the boiler shop, from which all of the tools, with the exception of the shear, derive their power, was continued throughout the afternoon from half past twelve until five o'clock. The results of this test are shown in the load curve diagram herewith.

A series of readings were taken at a time when no power was being used except for driving the shafting, two portable drills and a countersinker. These three drills were being used intermittently and probably did not require over one kilowatt of power as an average during the time when the readings were made. A reading of both current and voltage was taken every fifteen seconds for three minutes. An average of these readings showed the current consumption during this time to be 22.7 amperes at 238 volts, or 5.4 kilowatts. Deducting the remaining 4.4 kilowatts represents the power which is continually being consumed to drive the belting and shafting in this shop, not including several small counter-

shafts which were not in motion at the time.

This power at five cents per kilowatt hour represents a yearly waste of $660.00 most, if not all of which, could be avoided by the use of individual motor drive.

It appears, therefore, that the application of individual drive in this shop would not only improve the general conditions and increase the daily output, but the actual money saving in the cost of power consumed would pay good returns on the investment which such an equipment would require.

The introduction of electrical apparatus in the equipment of shops without fully knowing the reason for doing so is probably the explanation for the easily avoidable mistakes which the above description illustrates, and which it will be found is too often made by those shop managers who will not stop to find out exactly what sort of electrical equipment they will need and the best way of installing it. The shop man who is willing to "put his motors anywhere" is not worthy of using such apparatus at all.

FIG. 3.—SHOP IN WHICH ELECTRIC IDEA HAS NOT BEEN FULLY CARRIED OUT.

A systematic study of all of the detailed problems involved in the application of electricity to a given shop is a work in itself. Those shops and factories which have not as yet been equipped will do well to make a thorough investigation of their real needs before actually ordering their equipments.

There is no question but that the electric motor has proven its worth and many times over, and if those who use power were to appreciate this more than they usually do, they would be better off. One great difficulty, however, which everyone interested in the greater use of electrical apparatus has to continually meet, is the element of human nature.

The advantages of individual motor drive have been demonstrated for over fifteen years, and yet to-day one will hear people talk of it as though it were a new thing. Some will probably continue in blissful ignorance for years to come, while others will proceed to install their equipments without knowning how or why; but those who wish to obtain the full benefits will work out the details so they may know exactly what returns they may expect.

The accompanying half-tone engravings show portions of the shop herein described, and illustrates how electric motors may be in use and yet the full benefits of electric operation not be obtained because the electric idea has not been carried far enough.

BOILER FEED APPARATUS.

BY CHARLES L. HUBBARD.

Boilers are usually fed by small direct-acting steam pumps, although power pumps driven by the engine are sometimes used. The former require a large amount of steam in proportion to the power delivered, but this is small in comparison with that generated by the boilers, and is offset by certain advantages which this type of pump has over the power pump. The speed of the steam pump may be easily regulated to furnish the required amount of feed-water under varying conditions, while with the power pump it is necessary to run it at a constant speed and allow the excess of water to flow back into the suction pipe through a relief valve.

The principal objection to the *piston* pump is the difficulty experienced in keeping the piston tight, and of detecting leaks when they occur. On this account the *plunger* pump is often preferred. The advantage of this form over the piston is the ease with which it is kept tight under high pressures, and with gritty liquids the wear is taken by the bushing which is more easily and cheaply replaced than a cylinder lining. In order to examine or repack either a piston or single-plunger pump it is necessary to dismantle it. The two-plunger pump with outside yoke can be repacked from the outside, and any leakage may at once be detected. When two cylinders are placed side by side and discharged into a common delivery pipe it is called a duplex pump.

Theoretically, the quantity of water delivered by a pump in a given time is equal to "area of plunger × length of stroke × number of strokes."

Actually there is a certain amount of leakage around the plunger and through the valves, called "slip." This brings the actual capacity down to about 80 per cent of the theoretical in good pumps of medium size.

The following table gives the capacities of standard duplex feed-pumps for various speeds. These figures are based on 30 pounds of water per hour per boiler horse-power and 80 per cent slip. The speed of a pump is often expressed in piston speed instead of strokes per minute. This should not exceed 100 feet per minute as a maximus, and 50 feet or less for continuous working pumps is better.

Size of Pump.	30 strokes per min. B'l'r H.P.	45 strokes per min. B'l'r H.P.	60 strokes per min. B'l'r H.P.
2"x1⅛"x2¾"	7	10	13
3"x1¾"x3"	24	36	48
4½"x2¾"x4"	77	116	154
5¼"x3½"x5"	160	240	320
6"x4"x6"	250	376	502
7½"x4½"x6"	320	480	640

The propositions given in the table are for moderate to high steam pressures. If it is desired to operate the pump at a steam pressure much less than 20 pounds it should be provided with larger steam cylinders, depending upon the pressure at which it is desired to run it. In laying out a boiler plant it is advisable to use two pumps of such capacity that either of them running at a speed of 50 or 60 strokes per minute will deliver the maximum quantity of water required under ordinary conditions. This makes easy work for the two running together and allows a reserve pump.

The following data relating to water will be found useful in making calculations for the capacity of pumps:

Cubic feet × 62 = pounds.
Pounds ÷ 62 = cubic feet.
Gallons × 8.33 = pounds.
Pounds × 0.12 = gallons.
Cubic feet × 7.5 = gallons.
Gallons × 0.134 = cubic feet.

These figures will vary slightly for different temperatures, but are sufficiently accurate for ordinary use. The boiler power required for running a pump is computed in a similar manner to that required for a steam engine.

The rating or capacity of a pump, however, is usually expressed in gallons of water per minute raised to a given height, instead of in horse-power as in the case of an engine. The weight of water in pounds per minute multiplied by the height in feet, to which it is raised, divided by 33,000, will give the useful or delivered work of the pump in horse-power.

The friction of the moving parts of a pump and of the water flowing through the passages and valves is so great under ordinary working conditions that not much more than 50 per cent of the indicated horse-power of the steam cylinders is utilized in doing useful work.

This calls for a large consumption of steam in proportion to the work done, and from 80 to 120 pounds of steam per delivered horse-power is common in pumps of this class. The higher figure should be used for small boiler feed pumps, while 100 pounds may be taken as a fair average for pumps of moderate size.

The "head" against which a pump works is the vertical distance between the surface of the water in the suction reservoir and that in the discharge reservoir. If the pump is delivering against a pressure, as in feeding a boiler, the pressure is reduced to "head" in feet by dividing the pressure per square inch by 0.43.

Denver Convention of the National Electric Light Association

The twenty-eighth convention of the National Electric Light Association was held at the Brown Palace Hotel, Denver, Colorado, June 6, 7 and 8. The welcoming address was made by Mayor Speer, immediately after which Mr. E. H. Davis delivered his presidential address. Mr. Davis referred to the great and constant menace to electric light interests in the unwise and burdensome legislation by municipalities and states. State commissions, he said, are not altogether lacking in good features; but the association should make suggestions when laws affecting electric lighting interests come up for enactment. The appointment of a standing legislative committee was recommended. The president favored state associations for protective work and noted approvingly the proposal of the Association of Licensed Manufacturers of Incandescent Lamps to appropriate $10,000 for the purpose of cooperating effectively with central stations to increase by advertising and soliciting the sale of lamps and current. He also recommended the appointment of a committee to report on the proper method of grounding secondaries, and the continuance of the committee on steam turbines.

The presidential address was referred to a committee consisting of Messrs. L. A. Ferguson, F. W. Frueauff, George R. Stetson, Samuel Scovill and S. T. Carnes, who submitted the action of the committee at the final session of the convention. The recommendation as to the appointment of a standing committee on legislation was endorsed, and it was recommended that this very important matter be given immediate and fullest consideration of the executive committee. The suggestion for the encouragement of state and sectional organizations and cooperation with the proposed committee of legislation with those bodies was heartily approved. Following the submittal of the report, a resolution was adopted authorizing the expenditure during the coming year of a sum not to exceed $500 for such electrical tests as are thought advisable.

Brief abstracts of the papers presented, together with the discussions, follow:

Automatic Synchronizing of Generators and Rotaries.

This paper was presented by Mr. Paul Mac Gahan. The first improvement in synchronizing devices over the well-known phasing lamps was found in the "synchroscope," an instrument that rotated a pointer in synchronism with the difference in speeds of the machines. This instrument gives perfect indications of the phase relation between the machines at any instant and also indicates whether the speed of the incoming machine is too slow or too fast. It does not, however, make allowance for the time required to close the coupling switch. One of the best known of the early attempts at producing an automatic coupling device was embodied in the Pearson synchronizer. This device consisted of two controlling magnets mounted in the same case. One magnet was equipped with a time element which allowed it to close its contact when the difference in speed was small enough, and the other magnet would complete the switch-closing circuit when the machines were in exact synchronism. The author described in detail the new Westinghouse auto-synchronizer, and stated that it is a great advance in the handling of alternating-current generators and rotaries. In discussing the application of the device he remarked that an automatic synchronizer would be particularly desirable in the operation of large electric railway systems. When accidents occur which entirely shut down one or all substations it is exceedingly important to be able to start up with the least possible delay. If alternating-current starting motors are used and an automatic synchronizer is installed for each rotary, in order to start the substations it would only be necessary to throw in all the starting motors as quickly as possible and leave the rest to the automatic synchronizers.

Rotary Converters and Motor-Generators.

In discussing the means for the conversion of alternating into direct current, Mr. Louis E. Bogen stated in his paper that in this country only the rotary converter and the motor-generator are extensively employed, although the vapor rectifier possesses admirable qualities for this purpose. The disadvantage with the 25-cycle rotary resides in the low speed at which it must be run for low voltages in order to have a commutator of reasonable size. The design of the 60-cycle rotary is limited to such a narrow choice of dimensions as to be almost fixed, and it is better adapted to lower than to higher voltages. In response to a demand for something better than the 60-cycle rotary, there has been used in Europe a special form of double machine, composed of an induction motor to the secondary of which the collector rings of a direct-driven rotary converter are connected. The frequency applied to the induction motor is 60 cycles, so that if the motor revolves at one-half synchronous speed, 30-cycle e.m.f. will be impressed upon the converter proper. The paper described the various methods of starting rotary converters, and called attention to the necessity of properly adjusting the field strength to eliminate wattless currents, and mentions the use of reactance for assisting in parallel operation and for preventing hunting. The commercial forms of motor-generator sets were stated to be: (1), the combination of an induction motor and a direct-current generator; (2), a synchronous machine and a direct-current machine, and (3), two alternating-current machines coupled together for the purpose of changing the frequency in a system. For small motor-generators, the induction motor-driven set has numerous characteristics in its favor, but for larger sets the combination of a synchronous machine and a direct-current machine has a great many points in its favor in spite of the necessary auxiliaries. In operating a frequency changer in parallel with either another frequency changer or with a generator on the high-cycle end, there is but one way to connect the high-cycle end in parallel with the other unit. If the other unit happens to be of the same capacity and characteristics, the excitation of the generator end of the frequency changer must be the same as that of the unit with which it is to be brought in parallel, because after it is connected in a parallel a change in the excitation of either the motor or the generator will produce nothing but an interchange of wattless currents between the sets.

In the discussion which followed Mr. Clarence Renshaw, of Pittsburg, said that while it is difficult to design 60-cycle rotaries for high voltages, yet by proper skill such machines can be designed which operate entirely satisfactorily for direct-current voltages of 500 or even 600. He pointed out the very important advantage which the rotary possesses through its effect on line regulation. By proper adjustment a converter can be made to send a lagging current on the line or a leading current If induction motor-generator sets were used for operating railway load, a heavy draft of current would affect the voltage on the entire system, and when the cars let go the voltage of the system would rise. Rotary converters give a leading current on heavy load which tends to counteract the drop on the system, and when the cars let go the rotary gives a lagging current which tends to keep down the sudden jump of voltage which would otherwise occur. A motor-generator set driven by a synchronous motor would have the same effect. Mr. Alex. Dow, of Detroit, contended that distinction should be made between the apparatus discussed, as employed for railway or lighting service. In railway service it is possible to compound the rotary with the line to get the excellent results pointed out, but in lighting service, in which variations of voltage that are normal in railway work connot be tolerated, the conditions differ. Transformers for the rotary must be supplemented by regulating devices to give the necessary range of voltage control. In some recent stations the rotary equipment is both more complicated and more expensive than the motor-generator equipment. For lighting service the motor-generator under American conditions has very many advantages, while for railway service the rotary, even if it be the 60-cycle rotary, justifies its existence completely.

Series Alternating-Current Motors for Industrial Work.

This paper, by Mr. Clarence Renshaw, after discussing the constant speed characteristics of the induction motor and outlining the conditions under which a motor

possessing the speed-torque characteristics of the direct-current series is required, described a type of series alternating-current motor for both 25 and 60-cycle circuits which the Westinghouse Electric & Manufacturing Company has developed and placed on the market for industrial service. The motor is of the commutator type and is provided with an auxiliary field winding which is placed in slots in the pole pieces. The machine is a compensated motor similar in performance to the alternating-current railway motor.

A New Type of Single-Phase, Alternating-Current Motor for Elevator Work.

After having outlined the advantages of operating elevators by electric motors and having pointed out the limitations of the polyphase induction motor, Mr. S. Percy Cole described a type of motor which affords practically all of the desirable characteristics of the direct-current motor. This motor is the invention of Hr. Leo Schüler, an electrical engineer of Frankfort, Germany, and is made by the Wagner Electric Company, of St. Louis. In construction it is a combination of the repulsion and induction forms of single-phase motors. Mechanically, the motor consists of an ordinary induction motor frame. It has an ordinary induction motor stator core, built up of laminated sheet steel. The stator winding consists of form-wound coils, distributed in slots around the inner periphery of the stator core. The motor is built up of laminated steel in the same way as the stator, and carries a progressive wave winding similar to the usual direct-current armature; on one side is provided a commutator and on the other side three collector rings connected into the winding in polyphase relation. In operation the first effort of rotation is secured with connections corresponding to the well-known repulsion motor. After the armature has attained about one-quarter speed the polyphase resistance, connected to the armature through the slip rings, is thrown in and gradually short-circuited as the armature runs up to full speed. The brushes bearing on the commutator in the usual elevator equipment are not completely short-circuited, but have a fixed resistance interposed between them; at no time are the brushes removed from the commutator. An outfit which has been in service for six months has operated with extremely satisfactory results. The sparking is practically *nil*, and the life of the commutator is predicted to be equal to that of the best direct-current elevator motors.

In the discussion Mr. Alex. Dow said that up to the present the companies regularly installing elevator work, when asked for an alternating-current motor, evaded the subject. In reply to a question, Mr Cole stated that it is the intention of his company to develop the type of motor described in the paper for hoist and traveling crane service, and that they intended to cooperate with elevator manufacturers to whom they will supply the motors and speed controllers. Mr. Renshaw considered that the motor described corresponded closely to the direct-current, compound-wound motor. The motor is in the same class for such work as cranes and hoists as the induction motor. For elevator service the compound motor is what is desired, but for cranes and hoists and work of that class a series motor is necessary to get the full advantage obtained from direct-current service. In reply to a question as to why 25-cycle motors are wound for 220 volts and 60-cycle for 110 to 125 volts, Mr. Renshaw stated that a high frequency required a larger number of commutator bars and that a high voltage would make the bars too narrow for mechanical running.

Long-Distance, High-Tension Transmission in California.

The paper by Mr. John A. Britton gave a résumé of what has been accomplished in the past ten years in the development of the electric transmission systems now under the control of the California Gas & Electric Corporation. The paper describes both the old and the new arrangements employed in the power stations and in the transmission lines, thus indicating the arrangements which have best withstood the test of service.

The Organization of Working Forces in Large Power Houses.

The author, Mr. W. P. Hancock, gives a diagram showing the organization of the generating system of the Boston Edison Company, which has in service a total of 172 men. The specific duties and responsibilities of each man or group of men are outlined. It is stated to be the policy of the company to show every employe that his position has a value both to the company and to himself; to show that the value of the position to the employe was what the employe himself could make it, aided by the counsel and instruction of the superior who had his services in immediate charge; and by paying a uniform rate of wage for a uniform quality and quantity of labor in every line, the company has adopted a treatment of its men conducive to contentment and was reasonable in assuming and expecting good service.

Mr. W. B. Jackson, of Madison, Wis., in discussing this paper, spoke of the desirability of keeping a plant in a clean condition, not only owing to the effect in inspiring confidence in customers with respect to reliability, but also for the good effect on the morale of the employes. He said that when one goes into a dirty plant he sees slovenly employes, while when he enters a clean plant he sees bright, attractive employes who appear pleased with their work. In reply to a question Mr. Hancock stated that his plant paid firemen $16 a week if they were good men, and if not they did not want them. Operators are taken in at as low as $10 a week and moved up as fast as practicable. He said he did not have a union man on his pay-roll for the reason that a scale of wages higher than that of a union was paid. He believed his men were far above the average of the union men of to-day. For example, firemen get $16, whereas the union scale in Boston is $14 a week, and when delegates of the union call and are told that a higher scale of wages is being paid, they have nothing to say. The men are kept from becoming union men through being paid more wages than they could get as union men. Mr. A. C. Dunham, of Hartford, stated that during the last three years his men have been given an annual dividend of 6 per cent, and that there had not been any opening for a union man since this practice was commenced.

Operating Features of Vertical Curtis Steam Turbines.

A paper on this subject was presented by Mr. August H. Kruesi, who cited the experience already had with the Curtis turbines, and gave numerous suggestions as to the installation and operation of these machines. It is comparatively easy to secure such freedom from vibration in all sizes of turbines that a coin will stand on edge at the top of the machine indefinitely, and after having been brought to this condition when first started, the machine will require little further attention on this account. The shaft should run true and the bearing shield should be concentric so that the maximum excentricity will not exceed from .002 in. to .004 in. in turbines from 500 to 5,000 kw. capacity, respectively. To eliminate the packing at the lower end of the shaft the step bearing is generally lubricated with water, the shaft being fitted with a bronze sleeve running in a babbitt-lined guide bearing. By the use of a baffler it is possible to operate 500-kw. and 5,000-kw. turbines from the same pumps and piping system economically and satisfactorily under every condition. The step bearing has shown remarkable sturdiness when subjected to cessation of forced lubrication. To illustrate this a test has been made in which a 500-kw. turbine was run up to speed, lubricant and steam turned off simultaneously, the turbine brought to rest due to the friction of the step, and immediately re-started, six times in succession, without difficulty of any kind. After raising the lower bearing plate by means of the adjusting screw to compensate for the wear of the plates, they were just as good for further service as at the beginning, although naturally somewhat grooved. The type of valve mechanism which will ultimately prevail as the simplest and most satisfactory can be determined only by practical experience. With a view to ascertaining the best type, various forms of mechanically and hydraulically operated valves are under test in service conditions. The mechanically operated valves derive their motion from the turbine shaft under a fixed period, depending upon the turbine speed and, therefore, have no tendency to accumulate changes in speed or cause hunting. The governor controls the number of valves to be opened or closed by a modified Corliss release mechanism. The hydraulically operated valves are positively opened and closed by a cam shaft under the control of a hydraulic cylinder, the piston of which connects with a follow-up attachment which makes it absolutely non-hunting. After discussing turbine-driven auxiliaries, condensers and steam consumption, the author concludes that the saving in first cost alone

between the turbine and engine-driven units is equivalent in fixed charges to a reduction of the water rate. The saving of the condensed steam by the turbine, where feed water must be bought at ordinary city rates, is also considerable, as is that effected by the less attendance necessary for the turbine. All of these considerations, however, are of minor importance as compared with the reduction in steam consumption indicated by various tests, because there is hardly any part of the equipment of a power station whose capital and operating costs cannot also be reduced as a direct result, such as boilers, stack, coal-handling apparatus, condensers, pumps, etc.; or, in other words, a reduction of 10 per cent in the water rate of the turbine means a station of 10 per cent greater capacity and output for the same investment, fixed charges and operating expense.

In reply to a question, Mr. A. H. Kruesi stated that no turbines operating with exhaust steam are as yet in operation, but some are nearly completed and quite a number have been ordered. Two sets have been ordered by the Philadelphia Rapid Transit Company.

Some Investigations of Induction Losses.

Mr. E. P. Dillon's paper deals with the detrimental effect of the wattless component of the current in a supply system. After having mentioned the causes for the wattless current, the author determines the losses in a line having certain assumed constants and expresses the results in electromotive force, energy and dollars. It is suggested that synchronous motors may be caused to introduce leading wattless currents by over-excitation of their fields, and thus may be employed to neutralize the wattless currents in the system. The kilovolt-ampere rating of the synchronous motor for such work is calculated for assumed conditions. It is stated that the most prolific source of low power factor is due to the use of induction motors which are operated at less than one-half of the rated load. A remedy would be found in embodying in contracts a clause specifying that the motors installed shall have rated capacities within a certain percentage of their individual loads.

The Choice of an Insulated Cable.

Mr. W. S. Clark is the author of this paper. The size of the conductor is determined by well-known thermal and economical laws in most cable installations. It is important, however, that for underground construction there be not used cables so small as to be mechanically weak. A diagram is given showing the variation in cost per 1,000 circular mils of copper contained in the cable for different sizes of cables and different working e.m.f.'s, from which it is seen that, with a 15,000-volt cable, changing the size from No. 8 to No. 6 increases the cost less than 4 per cent, while the conductivity is increased 58 per cent. As to whether single or multiple-conductor cable should be used, it may be stated that for station wiring single conductors in separate ducts might safely be taken as the best modern practice, while for outside lines the determining factor will be the nature of the service. For low tension mains on the three-wire system the three-conductor cable is slightly cheaper than three single-conductor cable, but not nearly as convenient for making taps to customers. For low-tension feeders, which usually exced 25,000 circular mils in size, the concentric type of cable should be used for maximum duct economy. Smaller cables may be run as a flat twin conductor. For three-phase work, three-conductor cables, and for two-phase, four-conductor cables are required, on both economic and engineering grounds. The paper advocated a type of insulation now used by the General Electric Company which was claimed to possess all of the good qualties of paper, to be more flexible, to have a considerably higher dielectric strength, and which does not absorb moisture and can be used in interior work. These advantages are stated to be found in varnish and cambric, which will not deteriorate under temperatures destructive to rubber insulation.

Apparatus and Methods—Insulation Testing.

The writer, Mr. C. F. Skinner, discussed briefly the elements that should be considered in the design, selection and use of apparatus for making electric tests. In high-tension transmssion work the testing voltage is usually from one and one-half to two times the normal rated e.m.f. of the apparatus. Tests of 100,000 to 150,000 volts will cover any commercial work, and 250,000 volts should be sufficient for any investigation in connection with commercial work. Testing apparatus capable of giving half a million volts is merely a scientific curiosity at the present time. The author gives a table showing the relative ratings of testing transformers, from which it is noted that for maximum testing e.m.f's above 30,000 volts the current rating should be one ampere and for lower e.mf's the rating should be two amperes. Due to the charging current of a piece of apparatus considered as a condenser, for a given condition of test a larger testing transformer will be required for high than for low frequencies. It is stated that each of the 5,000-h.p. generators for the Niagara Falls Power Company has a capacity of about 0.3 microfarad, and the capacity of each of the 5,000-kw. generators of the Interborough Rapid Transit Company is 0.6 microfarad. The size of the transformer for supplying the charging power for the former machine at 25 cycles and 6,000 volts is 1.7 kilowatts, while that for the latter machine at the same frequency and 25,000 volts is 50 kilowatts. The three principal methods of varying the testing voltage when making dielectric tests are: (*a*), by carrying the field strength of the generator; (*b*), by means of a resistance in series with either the primary or the secondary circuit of the testing transformer, or (*c*), by bringing out loops from the high-tension side of the testing transformer, with further combinations of the low-tension windings. The last method is by far the most satisfactory. There are given numerous diagrams showing such arrangements suitable for both low and high-voltage machines. The author states that in the measurement of the testing voltage the method involving the use of the spark-gap has many disadvantages and few advantages. The voltage measurements are very unreliable unless an elaborate set of shields is used, and there is much controversy as to the actual distances which represent given voltages. A more satisfactory method is by the use of a voltmeter transformer. This method is very expensive with very high voltages for the reason that the voltmeter transformer is very difficult to wind and insulate for such small outputs. It is good practice in manufacturing work to test each part as it is finished, as well as the completed apparatus, in order that any defective workmanship or material may be discovered before the parts are finally assembled, and it is customary to grade the test voltages from higher to lower values as the apparatus nears completion. The paper is illustrated with a number of views of Westinghouse testing and regulating transformer outfits and by diagrams of connections.

Mercury Arc Rectifiers.

After discussing the various devices now available for charging storage batteries by power obtained from alternating-current sources, Mr. P. D. Wagoner described in detail the General Electric type of mercury arc rectifier. It is stated than the only part of the rectifier set that can require renewal is the tube and that the life of the tube under normal operating conditions is at least 400 hours, while some tubes have operated for 3,000 hours It is shown by means of calculation based on service conditions that the saving in cost of energy due to the higher efficiency of the rectifier set over a motor-generator set is sufficient to pay for a new tube in about 124 hours. The mercury arc rectifier makes possible the operation of the magnetite lamp from the well-known constant-current transformer on alternating current circuits. Such a system of street lighting has been operated by a central station for some time with remarkably satisfactory results.

The Tantalum Incandescent Lamp.

Dr. Louis Bell's paper gave an account of the test of some 25-hefner, 110-volt tantalum lamps used by the author and Prof. W. L. Puffer, two of the lamps being tested for decay. The light of the tantalum lamp is, as might be expected from its high efficiency, rather whiter than that of an ordinary incandescent, being as white as the Nernst lamp or the acetylene flame. Its distribution of light is in the present form of filament rather less uniform than that of the common incandescent lamp, being relatively more powerful in a horizontal zone and less powerful for points near the axis. The ratio of mean sperical to mean horizontal candle-power as found in Prof. Kennelly's investigation of the frosted lamps, proved to be .73 and Dr. Bell's figure from the clear lamps was substantially the same. The distribution, however, could very easily be improved, so that the spherical reduction factor would not differ materially from the usual figures and the light at the top could

be correspondingly increased. Since the tantalum filament has a low initial resistance (between 55 and 60 ohms) it jumps into incandescence with startling rapidity as compared with a carbon filament, but because of its positive temperature coefficient it seems to be decidedly less sensitive to changes of voltage in its working condition. This is a useful property in certain respects. The fact, however, that the initial resistance of the tantalum is so low and its thermal inertia so small owing to its small mass and low specific heat, means rather violent heating up, which is probably the cause of some doubts which have been expressed as to the endurance of these lamps upon alternating circuits. It is not difficult to imagine pretty severe strains upon the filament if it had time to cool down much between impulses. If such cooling could take place, for instance, on an ordinary alternating circuit, the results might be serious.

Some stroboscopic tests were, therefore, made at the last moment to determine whether at, say, 25 cycles, there was a specially violent fluctuation of light from the tantalum lamp; in other words, to find out whether on a 25-cycle current the filament had time to cool down materially. The result showed that the light fluctuation at this frequency was somewhat but not much more pronounced than in a carbon filament. The tantalum lamp behaved in fact about like a 16-c.p. carbon filament lamp. Even a 75-c.p. carbon filament lamp, however, shows perceptible variation under this test. At 60 cycles the fluctuation, while still perceptible, was trivial both in the tantalum and carbon lamps. It hardly seems probable that at 60 cycles the life of the tantalum would be enough impaired to cause serious trouble, but the writer now has some lamps on alternating-current tests and proposes to pursue the inquiry.

The tantalum filament seems to stretch and sag at first as if undergoing annealing and losing the set produced by drawing. Then it shows local bright spots which grow lumpy as if the material tended to flow a little from the heat, and with the increasing lumpiness the filament draws up tight. At this stage it is rather fragile and would probably break easily from vibration or shock. It seems likely that the final break comes just where one of the lumps has reduced the cross-section of the wire beside it. The break in the lamp during test, already referred to, showed considerable attenuation of the loose end.

The lamps tested showed the following characteristics:

Lamp.	Watts.	C.P.	Watts per candle.
Clear Globes....	41.58	21.42	1.94
	38.61	20.90	1.84
	41.58	24.93	1.66
	41.58	21.55	1.93
	41.91	21.81	1.92
	41.91	22.59	1.85
Frosted Globes..	40.36	19.79	2.03
	40.34	18.54	2.15
	40.04	18.74	2.13
	40.48	19.27	2.09

The mean result from the clear globes was 22.2 candle-power at 1.85 watts per candle; that from the frosted globes 19.98 candle-power at 2.1 watts per candle.

It is interesting to note that the clear lamp gives just about 1 candle-power per inch of filament, which implies an intrinsic brilliancy of somewhere about 500 candle-power per sq. in. of filament—a figure much higher than in the ordinary incandescent.

As illuminants the lamps are certainly very excellent, but their introduction raises some most interesting questions for the central station operator. Putting aside all the petty questions that will be raised about the new lamp for commercial reasons, the broad fact remains that we are here dealing with a bona fide 2-watt lamp having a life fairly comparable with the carbon filament lamps now customarily in use. Moreover, it is a competitor of these, socket by socket, and not as a substitute with particular requirements, as in the case of the Nernst lamp or the very small arcs. There is some doubt as to the life of the tantalum lamp when exposed to unusual vibration, which may perhaps bar it in some special locations, but for the everyday work of the central station there is good reason to believe it generally applicable.

Its price can hardly be said to be fixed in this country, but abroad in Berlin it is about one dollar (4 marks), which will give at least a fair line on its commercial results. On this basis and with power at 10 cents per kw. hour, one finds taking the new lamp on its 600-hour rating that the cost of its 12,000 candle-hours, including the lamp, amounts to $3.40. The same number of candle-hours from a lamp giving a mean efficiency of 1.25 watts per candle would cost $3.90, exclusive of lamps; that is, the consumer could afford to pay $1.00 for the new lamp better than to take the old ones free. With power as low as 5 cents per kw.-hour, the user of tantalum lamps could afford to pay only 75 cents per lamp as against getting carbon lamps free. This means that a sliding scale of discounts for lamps according to quality could be made to catch the consumer at all prices ordinarily charged for current by central stations.

Does this mean that the carbon lamp will shortly be down and out? Probably not, for there is no spur like competition to start up improvements, and there are some signs that carbon lamps may be improved enough in efficiency to make things interesting, at least with current at the prices charged to very large consumers. This, however, remains to be seen, and the thing which the central station man has to meet is the immediate probability of consumers putting upon their circuits lamps taking less than two-thirds the watts per candle-power of the best lamps now in use, and thereby cutting down their meter bills enormously. Now, broadly, what shall be the attitude of the central station man toward this income-scalping innovation? There are some managers who may be inclined to put up a fight to discourage the user, either by raising pettifogging objections or by trying to discriminate against 2-watt lamps by readjusting discounts in various ingenious ways. Dr. Bell is very strongly of the opinion that such a policy is wrong and will certainly lead to ultimate disaster in the form of municipal restrictions or regulation of rates by law. In the long run, opposition to improvements does not pay. If, on the other hand, the central station man hangs quietly on and gives the consumer the glad hand, the change will work to his ultimate benefit. In the first place, the tantalum lamps now made are of 22 candle-power instead of 16, and the filament will hardly bear much reduction in cross-section. The tendency, therefore, will be to use these slightly more powerful lamps taking, say, 42 watts instead of a trifle over 50 watts in the 16-c.p. carbon lamps. The actual loss in energy sold is likely, therefore, to be for the present quite a little less than the difference of efficiency would indicate.

Besides this, the attraction of cheaper light will certainly bring into line new consumers, so that the net result will probably be an actual increase in sales of current, quite a little of it being among the smaller consumers who pay the higher rates. Such a change means upon the whole more lights per unit of capacity in transformers or feeders, and hence a slightly better utilization of material and improved load. In the case of stations with underground service, the change to 2-watt lamps ought to bring with it increased earnings per unit of cable capacity. The fact is that improvements in the efficiency of utilization of electric energy help the business, and it is both fruitless and inadvisable to oppose them from any short-sighted notion of small temporary savings.

As to the inevitable competition between present lamps and the newcomer, in the first place, the merits of the final issue remain to be determined, and in the second place competition in lamps is, on the whole, a good thing for the user of them, however it turns out. So far as the central station is concerned, it is a case of dog eat dog.

The really important thing is that from now on the station manager will have to deal directly with the 2-watt lamp proposition, for there is no disguising the fact that it is here, and in a form which is quite unexpected. The appearance of tantalum lamps in quantity may be a little delayed in this country, but delay will improve them as in the case of every new product, and will serve to assure a better understanding of their truly remarkable properties and of their possible limitations. The unexpected has certainly happened, for most engineers had long ago abandoned the idea of a lamp with a metallic filament. Only the discovery of a metal virtually new, and possessed of most sensational qualities, could have brought about the present striking result.

In the discussion of Dr. Bell's paper, Mr. Arthur Williams, of New York, stated that his company had a number of these lamps on test and they promised a very marked improvement in the economy of incandescent lamps in the future. He believed, however, that if the price of the lamp remained at its present figure, $1 in Germany and perhaps $1.50 or $2 here, it would not be a serious competitor with the incandescent lamp; and as there probably have not been more than 100 of these lamps in this country and they have not been here long enough to be subjected to any commercial test, he

did not think it would be practicable to discuss the lamp in any commercial sense. The high lamp cost will minimize it as a factor in competition with the carbon filament lamp.

Mr. John F. Gilchrist, of Chicago, considered that the new lamp raised the question of selling electricity for illuminating purposes on the lamp-hour instead of kw.-hour basis. The new lamp would cut down the income of the station, and while it is unwise to attack anything which has merit, the station manager may want to hold it back until he can build up his business to meet it and not impair the income. He suggested that the association and electric light men should guide legislation along the lines of charging on the flat hour basis so that a new lamp of the tantalum type could be used by central station men with advantage to themselves. Mr. A. C. Dunham, of Hartford, Conn., said that he had experimented with the tantalum lamp and found that the figures given in Dr. Bell's paper are practically correct. They will burn a long time after a filament breaks, the filament mending itself. He referred to the system brought into vogue by the osmium lamp, where central stations are charged 20 cents per lamp per month rental, the manufacturers supplying repaired or new lamps for lamps burned out. Mr. Dudley Farrand said that his station had two of the tantalum lamps. One showed a consumption of 1.99 watts, but lasted only 20 odd hours. The second lamp is still burning and has shown a consumption of 1.68 watts. Mr. Farrand did not think that the tantalum lamp would work against the interest of the central station at all. Every time the efficiency of a lamp is doubled the capacity of the plant is doubled, and while the higher efficiency may tend to increase the distribution expense, the net result will all be in favor of the high efficiency lamp. He expressed himself as highly in favor of the tantalum lamp and only wished he could get them in sufficient quantities to supply his business to-day. He did not consider it would upset the commercial status as the business would increase with the introduction of the lamp faster than the lamps could be put into use. Mr. W. H. Gardiner, of Boston, thought that the new lamp would enable the candle-power of lamps to be increased to compare with that of gas or to about 25 candle-power as a unit. He welcomed the opportunity to increase the candle-power rating and pointed out that a similar increase had worked well for gas companies upon the general introduction of the mantle gas burner.

The Nernst Lamp—Its Present Performance and Commercial Status.

Mr. E. R. Roberts' paper presented the results of a series of life and photometric tests of Nernst lamps recently made by the manufacturers. The method of making the tests and the photometer used were fully described. During the life tests the lamps were operated under what is considered good maintenance conditions, the globes and holders being cleaned every 200 hours. The decrease in mean hemispherical candle-power amounted in 1,000 hours to 22 per cent, the greater part of which took place in the first 300 hours. The initial consumption per mean hemispherical candle-power was 3.31 watts and per mean hemispherical candle-power was 1.95 watts. At the end of 1,000 hours the values had increased to 3.78 and 2.27, respectively. It is stated that, while the Nernst lamp properly belongs to the class of incandescent lamps, from the maintenance standpoint it is more akin to the arc. From the reports of the 7,000 glower units in service in the Pittsburg district it is learned that the total maintenance cost per glower per month is 9.56 cents, and it is estimated that the cost for maintenance per kw.-hour of energy used is 5.2 mills. This figure agrees closely with the average cost reported by a number of companies who use the lamp on a large scale.

Replying to a question concerning direct-current lamps, Mr. Roberts stated that arrangements have been made to distribute a number of these lamps to central stations for commercial tests, and the result of these tests will be awaited before the lamp is placed regularly on the market. Mr. Arthur Williams said that his experience in New York City showed that the Nernst lamp does not materially interfere with the field of incandescent or arc lighting, but fills a gap between the two. The light is of high quality and wherever used gives entire satisfaction. The three and six-glower lamps are more advantageous commercially than the single-glower lamp. The life is fairly satisfactory and the cost of renewal slightly over one cent per kw. hour, and probably would be less than one cent were the lamps used to a larger extent. The income is substantially $11 annually per 88-watt glower, which is about twice the average income of an incandescent 16-c.p. lamp. Through the Nernst lamp the New York Edison Company has secured the return of a large amount of business which had gone to intensified gas burners. Mr. A. C. Dunham, of Hartford, Cann., said that he was using 3,500 Nernst lamps and the lamp has filled the place so well that they do not see how they could possibly get along without it. As a displacer of high candle-power gas lights it is remarkable. The life of the glower is now from 800 to 840 hours, though one lamp has now been running over 1,700 hours. He did not think it advisable to get the full life out of the glower, as this would almost surely result in burning out the heater, which is a very expensive affair, the list price being 75 cents. Single glower lamps are not allowed to burn over 450 hours. In the case of a rated 50 c.p. Nernst lamp it would burn for the first 50 hours 71 candle-power then drop to 62 and stay there for 450 hours, after which it begins to drop more rapidly. He considered that if the price of glowers was greatly reduced sales would increase very materially. In reply to a question, Mr. E. R. Roberts stated that the Nernst lamp was used for street lighting in Unionville, Conn.; Sewickley, Pa.; Burlingame, Kan.; Burwin, Ill.; Goldfield, Nev.; Golden, Col.; Deming, N. Y., and Coalinga, Cal.

Sign and Decorative Lighting.

The author, Mr. Larue Vredenburg, dealt with the subject from its purely commercial side. One thing that has acted as a decided handicap to the introduction of electric signs in many cities and towns is the restriction placed by ordinance on the size and position of signs. A properly directed effort on the part of the lighting companies will undoubtedly tend to the correction of this condition, as the benefit accruing to any town from the added illumination of its streets by means of signs is so self-evident that but little argument is necessary. The method pursued by one of the large companies last year was a persistent and systematic advertising campaign by means of letters, return postal cards and enclosed stamped envelopes, sent to a selected mailing list including all retail merchants in all lines of business whose stores were sufficiently pretentious to possess plate-glass windows. This campaign last year resulted in more than doubling the number of sign customers in a city where an ordinance restricts the projection of signs to two feet from the sidewalk line. Consequently, most of the signs installed are placed either vertical or flat against the face of the building. A field that shows quite a promising crop for lighting companies is the illumination of bill-boards. These are generally controlled by advertising concerns, who are beginning to appreciate the increased value of their space when properly illuminated.

Another type of sign which appeals strongly to the general advertiser is the so-called "talking sign." This sign, although quite expensive to install and adapted to use in only the larger cities, is of such versatility and attractiveness, enabling the user to present such varied and extended arguments, that it should prove a profitable investment.

Free Signs and Flat Rates.

Mr. C. W. Lee, the author of this paper, considered only that phase of the subject which relates to the possibilities presented in the use of the electric sign as a means of obtaining long-hour customers. The flat rate has a particularly good effect on sign lighting, as it insures use of the sign six or even seven nights a week, while those operated on a meter basis are used only the nights when the store is open, which is the time when there already exists a large demand for the current. With a view to further increasing the sign business the company with which the author is connected has recently placed in operation a plan whereby the greater portion of its sign lighting will be entirely removed from its peak during the months when the peak must be considered. Free signs on a flat rate for certain stipulated hours each night are the nucleus of this plant. The time of switching on is placed about half an hour after the peak load. The turning on and off of signs is controlled by patrolmen, who not only attend to these duties but inspect all signs as well as solicit new business. It is expected that as soon as this plan is under full headway the increased business will necessitate the running of

special sign circuits from the station. In this event the expense of patrolmen would be eliminated. Isolated signs at some distance from the main streets are controlled by time-switches. Before the adoption of this flat-rate schedule it was argued that no customer would be willing to contract for a sign that could not be turned on during the first half-hour of darkness, but experience has proven that this question is waived in many instances, the specific rate overshadowing this point.

Both of the foregoing papers, together with a paper on "Advertising Methods," by Mr. Percy Ingalls, were discussed together. The discussion brought out the fact that advertising in its various forms pays. The methods pursued in various large cities, especially Denver, were expatiated on and it was shown that even in comparatively small towns where competition with cheap gas was keen, excellent results were obtained by intelligent and systematic advertising. For increasing business nothing else was comparable to it.

Report of the Committee on Progress.

After giving numerous statistics of the industry showing developments abroad and in America, the report by Mr. T. C. Martin takes up the subject of illuminants. Descriptions are given of impregnated carbon arc lamps, mercury vapor arc lamps, tantalum filament incandescent lamps, the osmium and the cadmium lamps. In discussing the unexploited fields for the use of electric power, the author drew attention to the advantages to the central station of acquiring a refrigerator power load, and stated that wherever power can be furnished at a rate less than 5 cents per kw.-hour automatic refrigeration by means of apparatus now available effects a large saving over the cost of ice, even if the manifest advantages of cleanliness and convenience of operation be not considered.

Report on Present Methods of Protection from Lightning and Other Static Disturbances.

This report, by Mr. Alex. Dow, forms a brief review of present practice and does not attempt to give any new theories or to describe any untried devices. It is the function of the lightning arresters to protect the apparatus used in transmission lines from lightning, from high-frequency waves set up by sudden changes of load or by resonance, and from static charges. The essential features of a protective apparatus are as follows: (1) They should discharge at a potential slightly higher than that of the system. (2) The ordinary working of the system should not be affected by the discharge. (3) The electric energy of the static disturbance should be dissipated as rapidly as possible. (4) The static waves should be prevented from developing high-potential differences in generators, transformers and other apparatus. Among the various devices used for protection the author describes the General Electric arrester for 2,000 volts, the Westinghouse arrester for 2,000 volts, the Westinghouse low-equivalent arrester, the horn arrester and the water-jet arrester for alternating-current systems, and describes the Thomson magnetic blow-out arrester, the Westinghouse direct-current arrester, the Garton arrester and the Westinghouse tank arrester for direct-current systems. He concludes that there is still much to be done before it can be claimed that the lines are perfectly protected. The engineers of the manufacturing companies have developed apparatus that operates successfully under ordinary conditions, but each transmission lines presents a separate problem which can be solved only empirically.

In the discussion of the paper Mr. Dow said, referring to the water jet arrester, that this was merely a leg of high resistance and of no inductance, and that it consumes energy continuously. The water jet might be used to good purpose in many high-tension transmission lines as a special protection during thunder storms in much the same way as in certain railway plants the tank arrester is switched on during thunder storms. In conjunction with choke coils it would furnish a thoroughly reliable means of protection, though its use involves a loss of energy from 3 to 10 kilowatts, depending upon the voltage. From information received since the report was prepared, the use of a single ground wire, instead of two, was recommended. No reliable information could be obtained concerning the horn arrester, but it seemed that the tail piece is dispensed with entirely in many European plants. Mr. Dow advised the appointment by the association of a reporter to gather information on the subject of lightning protection and to report the same at meetings. In reply to a question, Mr. Dow said that flashing across storage battery terminals to ground has happened, the discharge being across the surface of the tanks. Mr. R. F. Hayward stated that in Utah there are about 300 miles of 40,000-volt and 200 miles of 28,000-volt lines running in parallel, and scarcely any storm passed through the territory covered without striking something, either directly or inductively. He has come to the conclusion that the lightning protection should be spread all over the line in the form of lightning conductors. It is found that when a storm occurs it will generally strike the lines and split a number of poles, shattering all the insulators on one pole and puncturing a number of insulators on other poles. The effect is seldom found far from the point where the stroke comes, and if the stroke is near the power house some apparatus is likely to be lost or terminals burned out. A number of transformers of the old air blast type have been lost, but none of those with new windings which have replaced the old type, although in a recent storm some of the terminals were burned off. The arc will cross from terminal to terminal, jumping distances of 5 or 6 inches, and while this shuts down the plant for a moment, no other damage is done. Recent experience has shown that modern insulation, whether of the air-blast or oil type, is becoming very good and very high. Mr. Hayward considered that the ground wire should be placed on the line; if there is no ground wire on the line, one of the two circuits is grounded at each end of the line when a thunder storm comes along. If a ground wire is above the other lines, it should be as far above as possible, for then the stroke will discharge to this wire and take the ground by a number of different paths, whereas if the ground is at the neutral point of the main circuit it is almost certain to cause an arc that will give a short circuit, and these sudden short circuits are the cause of setting up low-frequency waves which go into the power house, pass through the choke coil and are liable to break down the apparatus.

Mr. E. P. Dillon stated that the Colorado Springs lines were partcularly menaced by lightning. At present lightning arresters are liberally distributed at the various plants and sub-stations, but there are none on the line, since it is felt that the risk of having lightning arresters on the line was an offset to their advantage. He thought that a well-constructed ground wire would obviate some of the difficulties which have been met with. At three different times in the past two years the lines have burned out directly in the middle of a span, and not at the poles. Last December during a heavy wind there were some exceedingly severe static discharges from the lightning arresters which appeared to be heavy enough to destroy apparatus, though taken care of by the arresters. Lightning and static disturbances are practically unknown at high altitudes, while valley lines suffer severely. This he considers to be due to the fact that the clouds come down so low that there is not much of a chance for a great difference of potential between them and the earth. On the Pike's Peak hydro-electric plant there are installed a combination of spark gap and high-resistance arresters and a water tank, which combination has carried the plant through several severe storms. Mr. Dillon did not approve of barbed ground wire owing to the uneven quality of the wire, which caused it to break and give rise to more serious trouble than from lightning. A well-made steel wire of good tensile strength would give very good protection and help out the regular arrester. At the main generating station high-resistance arresters were installed in combination with the spark gap; these did not completely take care of the trouble and about two years ago they were put in a series parallel arrangement giving the discharge a straight path to ground or a split through the arrester, and since then there have been no discharges at the switchboard. Mr. George R. Stetson, of New Bedford, Mass., said that last December in two weeks more motors were destroyed than in all the previous fourteen years in the operation of the plant, due to a static manifestation. Some of the motors were served by the underground system and some by the overhead system, and finally the trouble went beyond the motors to the station generators. The trouble to some extent has been remedied by putting up lightning arresters and kicking coils. Mr. Orville A. Honnold, of Salt Lake City, said that in experiments with lightning arresters several types had not given good results, and he believed that the

Pike's Peak plan would solve the problem. Mr. H. T. Hartman criticised the suggestion to locate the ground wire at the center of the three-phase diagram for the reason that this would virtually reduce resistance between the wires. Mr. W. B. Jackson, of Madison, Wis., stated that in northern Italy the water jet arrester has recently been put in use, and since then the former trouble from static effects has ceased. Mr. Dow stated that the water jets on the Italian lines are very satisfactory, and he thought that this was the most comprehensively reliable arrangement available for protection against either lightning or static discharges, when installed in connection with choke coils. The objection to the jets is that they take energy, but they may be held as emergency devices and thrown into service only upon the appearance of symptoms of static discharge. As to the position of a ground wire with reference to a three-phase line, this point would be at earth potential if, as is usually the case with Y-connected step-up transformers, the central station point of the wire is connected to the earth. He considered that the experience of Mr. Stetson was due to quick breaking of short circuits, which put a bad stress on a line. As to lines charged statically, sand storms produce the most aggravated cases. In conclusion he stated that it cannot be made too strong that the provision of low-resistance, non-inductive paths to ground is the perfect type of protection.

Report on Purchased Electric Power in Factories.

Mr. E. W. Lloyd's report contains a compilation of valuable data connected with the electric power loads on the central stations belonging to the association. In discussing the question as to whether a factory should run from central station service or whether it should generate its own power, the author stated that the decision is not always governed by the rate per kilowatt hour which the central station company proposes to charge for the power. To anyone who has had experience with installations of motors driving machinery where one large motor was used, it is known that no economy can be obtained over engine drive with profitable rates for central station service. It may be possible with the use of a few motors in a large plant running 15 to 24 hours a day with a low rate per kilowatt-hour, that central station power can compete with engine drive; but the average plant does not run more than ten hours a day, and, therefore, the rates of a central station company doing a profitable business cannot compete successfully with these conditions. It is, therefore, necessary to consider other sides of the factory power subject than merely the question of price per kilowatt-hour. While it is true that the installation of individual motors increases the connected horse-power load in a given factory over and above what it would be should group-drive installation be made, it is also true that the energy consumption is considerably less on the individual motor installation. There are engineers throughout the country who advocate individual motor installation, but the subject has not received the proper consideration from all central station companies, and the sooner it is brought forcefully to their attention that this type of installation will do more to increase their power load than any other one thing, the more universal the practice will become. The selling by some companies of electric power at very low rates even to the extent of losing money on this power is not necessary with proper motor installations. Extremely low prices for electric power in some localities are detrimental to the station business in others, and they are not necessary if the proper attention is given to the engineering features in obtaining power business.

In the discussion Mr. A. C. Dunham, of Hartford, Conn., said that his plant is now operating a little over 5000 horse-power in motors. He referred to one case where a manufacturing company opened its books showing the cost of its steam power and agreed to pay 20 per cent more for electric power, which offer was accepted. He has found that the output for the motor service is about 40 per cent of the rating of the motors connected. Mr. H. J. Gille thought that a good source of revenue could be derived by supplying power in the summer time where there are isolated plants; as one of the principal objects of such plants is to supply steam for heat during the winter, they could with profit be shut down in the summer time and current for lighting taken from the street mains. Mr. W. C. L. Eglin called attention to the fact that averages with relation to motor installations might not mean much for the reason that one or two large motors in a machine shop, for example, might give a large average, whereas many small motors might be in use. Mr. Gilchrist showed the desirability of determining the actual cost of steam power to a prospective customer of electric power, in order that figures could be derived to show the superior economy of electric power. He related an instance where, after such a study of a plant, an owner who had used some steam for drying lumber was induced to put in a hot air kiln for this purpose to use up refuse; it was then found that the cost for electric power per month involved a considerable saving to the factory. As to averages, taking the case of machine shops, which run from 12 per cent to 70 odd per cent of the connected load, to strike an average bebetween the two of, say, 40 per cent, would give no criterion. Taking all the installations of, say, four motors or more, it would be found that the highest average is 62 and the lowest average is 40 per cent.

Electric Heating.

Mr. J. I. Ayer presented the report of the committee on "Progress in Electric Heating." In order for electricity to compete with gas at $1.00 per thousand, current for cooking must be 3 cents per kilowatt-hour. It required about 300 watts per day per person for electric cooking, and the wiring should have a capacity of at least 35 and not more than 45 amperes for a family of four to six persons. Progress was chiefly made in the use of electricity in laundries. The use of electricity for heating dwellings and water was not advisable, considering that this could be done more cheaply otherwise.

District Heating.

The report of the committee on district heating was submitted by Mr. W. H. Blood. From the report it appears that 84 per cent of the companies approached find their investment in the heating business a good thing, which 16 per cent. were not at all satisfied with the business. It was stated that all direct-current plants are located near enough to the center of distribution to warrant district heating. For a central station which is a mile or more away from the center of the city, however, district heating is generally out of the question. An element of extreme importance is the relation of the cost of steam coal to that of domestic coal. In cities where steam coal costs from $1.00 to $2.00 per ton, and where domestic coal costs from $4.00 to $9.00, the company has much in its favor and should be able to make rates that are at once attractive to the public and profitable to itself. It seems safe to estimate for ordinary conditions where exhaust steam is used about .2 pound of water per hour per square foot of radiating surface. So long as the demand does not exceed the supply of exhaust steam, but follows it closely, and the rates are kept up, the plant is in a fair way to make money; but any plant that undertakes to sell live steam on an exhaust-steam basis is doomed to failure.

The association issued to its active members at Denver three highly important documents. The first of these was the report on "Municipal Ownership," by Mr. Arthur Williams. A large number of plants are considered in it in detail, and Mr. Williams' results should be found extremely serviceable by persecuted central station men all over the country. The book is a volume of over 200 pages, carefully digested and indexed and bound in cloth cover. The other two productions given out were the "Question Box" and the "Wrinkles" pamphlet. The former, edited by Mr. Homer E. Niesz, is a volume of 594 pages, replete with information, containing 3057 answers to 545 inquiries relating to all branches of the light and power art. "Wrinkles," edited by Mr. H. C. Abell, deals in like manner with minor problems of the business and in 117 pages gives a profusion of useful data.

The last three days, June 9, 10 and 11, were spent at Colorado Springs, in sightseeing and pleasure, the business of the convention having all been transacted in Denver.

Following are the officers elected for the ensuing year: President, Mr. W. H. Blood, Jr., Seattle, Wash.; first vice-president, Mr. Arthur Williams, New York; second vice-president, Mr. Dudley Ferrand, Newark, N. J. The following gentlemen were elected members of the executive committee, to serve three years: Mr. Charles L. Edgar,

Boston; Mr. John Martin, San Francisco; Mr. Frank W. Frueauff, Denver. Mr. L. A. Furguson, chairman of the nominating committee, stated that formerly the secretary-treasurer was appointed by the executive committee, but as this officer is no longer a salaried employe, he suggested that it would be a complimentary action for the convention to elect him. Acting upon the suggestion, Mr. W. C. L. Eglin, of Philadelphia, was elected secretary-treasurer.

CITY REFUSE AS FUEL IN ELECTRIC PLANTS.

BY GEORGE E. WALSH.

The utilization of city garbage and refuse burned in modern dust destructors for the generation of electricity appeals with particular force to municipal authorities where geographical conditions make the disposal of street cleanings costly and cumbersome. English towns and cities have been far ahead of American municipalities in experimenting with combined dust destructors and electrical-generating plants, and the pioneer experimental work performed abroad throws considerable light on the problem for engineers in this country. For upward of three or four years now about fifty towns in Great Britain have had in operation combined dust destructors and electrical works, and of the remaining 120 towns that dispose of their garbage in destructors a fair percentage are making plans to combine electrical plants with their incinerating works.

Eight years ago consulting electrical engineers were opposed to such combinations of destructors and electrical-generating plants, but to-day in England very few offer objections to utilizing refuse as fuel for generating electric light or power. The chief consideration is to find some more economical method of burning the refuse so that as many heat units as possible are utilized, and the experiments conducted furnish abundant data to indicate certain lines of improvement important to the electrical industry. It is fair to assume in the light of experiences with dust destructors and electrical plants in England that within the near future few first or second-rate American cities will waste their refuse by dumping it in the ocean or by burning it in incinerating plants which do not utilize any of the heat. The dust destructor that furnishes steam power either for direct mechanical purposes or for generating electricity will become the rule instead of the exception in American cities.

Refuse of cities is low-grade fuel, inferior to coal, but with certain important steaming qualities. Its heat value varies considerably at different seasons of the year, and even from day to day. The average refuse of a city is much less valuable for fuel in summer than in winter, and on wet days it comes to the destructors in such a condition that it lowers the temperature of the furnaces if fed directly to them.

In consequence of this variable value of refuse as fuel the use of coal together with the garbage and sweepings has been found universally necessary. In the early days of the dust destructor the opinion prevailed in some quarters that eventually the refuse of cities would be burned in destructors without the use of any coal at all, and that the steam or electric power thus obtained would represent a distinct gain of the city, minus the fixed charges on the cost of the plant and the labor of handling and operating it. One of the largest and most important combined plants was constructed in England with this idea in view, and its subsequent history is interesting. The Shoreditch plant in London was erected with the idea that there would be sufficient refuse to supply electric light and power for public purposes without the use of coal. To-day, instead of depending upon refuse alone, this plant is one of the largest users of coal of any in London or the suburbs. Last year 6,376 tons of good Welsh smokeless coal was burned in the destructors and 25,729 tons of refuse. This was due to the fact that the electric station load increased much more rapidly than the supply of refuse fuel, and in order to secure uniform power coal had to be burned at various times.

Since the Shoreditch experience few, if any, destructors and electric plants have been built for the consumption of refuse alone, except on a small scale. The use of both coal and refuse is considered absolutely essential, and even where small plants have been constructed for burning garbage alone it has been found that in the second or third year the load increased so that coal had to be added to the garbage.

With the question of the relative low fuel value of refuse, engineers have had to consider the problem of feeding the fires with such a clumsy fuel as city refuse. Instead of being a compact fuel, the refuse is bulky and oftentimes unwieldy. Feeding such fuel is difficult and wasteful under ordinary conditions. When dumped into the cells in bulk the large mass ignites much slower than coal, and while the leveling and spreading process proceeds the cell grows cool and inactive. When fed with hand shovels the mass of material releases heat units faster, but its consumption is very much quicker than more solid fuel like coal. Mechanical stoking machinery which will feed the cells uniformly and without cooling off the combustion chamber has been found not only economical but absolutely necessary in order to obtain much profit from burning city refuse.

Various types of cells, boilers and combustion chambers have been used in England to overcome the difficulties caused by the nature of the fuel, and the designing and arrangement of the dust destructors and the electrical works represent ingenious application of principles to an end that are of instructive importance. The early types of dust destructors had a low rate of combustion, and, limited by natural draft, the temperature of the gases entering the boiler-heating passages rarely exceeded 800° Fahrenheit, and more frequently averaged 600° to 700°. In the improved dust destructors of to-day the gases enter the boiler tubes or passages at a temperature of 2000° or more, with a minimum temperature of about 1600°.

This remarkable improvement has been obtained either by arranging the fuel cells in pairs so that one is always working actively while the other is being charged and clinkered, or by having a continuous grate with divided ashpits. Both of these types are now in use in England. The former is arranged so that the boiler is placed between two cells, with one combustion chamber common to both cells. The gases from the two cells then mingle in the main flue, and when one cell is cooled or inactive through charging and clinkering the other prevents rapid cooling of the combustion chamber. In this type of destructor one cell may be quite cool while the other is filled with gases at very high temperatures.

Where there is installed a continuous grate with divided ashpits, such as the Meldrum system in use in England, a single cell of some 100 square feet of grate surface supplies heat to the combustion chamber. A separate ashpit for every 25 feet of grate divides it into four compartments. When one division is being charged and clinkered the hot gases from the other three pass into the combustion chamber without being materially affected by the single one out of use. Three-fourts of the large single cell is thus kept in active operation at all times, and no great volume of green gases is ever permitted to enter the combustion chamber at one time.

The application of the regenerative system of supplying heated air for combustion to destructors promises also to add materially to the advantages of refuse burning. This system maintains a very high temperature when coal is burned, and it should prove even more economical when refuse is used as fuel. The use of heated air tends to increase the efficiency of the fuel and promotes rapid ignition, insuring a continuously high temperature. The use of the regenerator with the dust destructor is of particular value in rainy weather when the refuse comes in very moist. The application of some system for heating and drying the wet fuel is one of the problematical features now being tried out.

The actual destroying capacity of the destructors in operation in England with which electrical-generating plants are combined averages nearly 2000 tons of refuse daily. The largest destructors are considerable consumers of coal, and they are adapted to various uses, such as electric lighting, pumping water, heating plants, etc. The largest consumer of refuse in connection with an electrical plant is the destructor at Stepney, London, which burns between 40,000 and 45,000 tons of city garbage and refuse a year, together with about 2350 tons of coal. The proportion of coal to the refuse burned is small at this plant, but coal is used here only to aid the destruction of the refuse and not for generating steam for other purposes. The total number of units developed from the refuse consumed at the Stepney plant are nearly 1,200,000 in round numbers, and about 750,000 units from the

coal. The average number of units obtained from burning the refuse for the year was 28.3, and the highest for a week or more continuous burning in winter 40 units. The whole amount of steam generated by the plant is used for operating the clinker hoist in connection with the destructor, a disinfector and the electric-generating plant. The electric plant is located some 200 feet from the destructors and is supplied with steam through piping.

The destructor furnaces are composed of 12 Manlove-Alliott cells and six Babcock boilers. The furnaces are supplied with forced draft by steam-driven fans, and steam also operates the clinker-hoist independent of the electric plant. No economizers are used at the Stepney destructors, and no other machinery is operated by steam direct.

The engines of the electric-generating plant receive steam through the 200 feet of piping from the destructors; high-speed, vertical, non-condensing engines drive the generators, most of the exhaust steam being utilized for heating the feed-water. There are two generating sets; one set is run continuously throughout the day on destructor steam and the other during the night when the load is at its height. In the past the full supply of steam has not been consumed by the electric plant, and during light loads a good deal of surplus heat has been wasted up the chimney. The plant was designed, however, to accommodate the needs of the community in the future as well as at the present time, and the waste of heat will cease as soon as the demand for the electricity catches up to the output ability. During the hours of heavy load when the supply of refuse runs short, coal is used in the destructors.

The Stepney plant has proved satisfactory since its combination with the electric works, and further improvements are being made to extend its usefulness and cut down the cost of production. One of these is the construction of a new chimney, the old destructor chimney proving inadequate; it is also intended to install economizers. Three extra boilers have been put in during the past year, also new pumps and a water-softening plant. In its practical workings the Stepney plant has come out second best in the matter of costs, and with future economies through contemplated improvements a further saving may follow.

Taking the destructors in the order of the amount of refuse annually consumed, the combined destructors and electrical works at Hackney stand second to the plant at Stepney. About 34,000 tons of refuse are burned in the Hackney destructors, and with only 1255 tons of coal used in addition, the output stands unusually high. The total from refuse and coal stands at about 1,256,000 units, with nearly 125,000 used for operating the fan motors. The steam generated at this plant is used solely for driving electric generators. The destructors consist of three four-cell groups, with a combustion chamber between each two pairs of cells, which leads direct to the settings of three Babcock boilers. The generating plant consists of high-speed engines and direct-current generators, with a 1200-kw.-hour Tudor battery. The highest record obtained at the Hackney plant has been 60 kilowatt-hours per ton. The destructor costs have been found high, the chief items being high wages and the high cost of disposal of the clinker. In fact, disposal of the clinker has proved the most expensive item in the past in nearly all of the destructor plants. The problem of reducing this cost has in a few instances been satisfactorily solved. If the clinker can be sold as a by-product at a small profit or at cost of removal, the destructors would prove far more profitable than they are now. A large proportion of the total costs of the destructors has been caused by operating the clinker-working plant and disposing of the by-product afterward. At the Fulham plant two years ago the cost of the disposal of the clinker amounted to nearly $2400 and at Hackney $3750. At both of these plants arrangements have been made which will eliminate this item, and the cost of operation will thus be materially reduced. The clinker proves of sufficient value in some parts of the country to justify its being removed by contractors at cost. The Hackney plant has a good deal of surplus steam and electric power in the daytime which has had no adequate market, and as a result the showing of this plant has not been as satisfactory as some of the others. With a more favorable market for steam the plant should earn a profit that to-day is lacking.

The Fulham destructor and electrical works burn over 30,000 tons of refuse annually, supplemented by nearly 2,000 tons of coal. As the most economical combination plant in London, its operation is interesting. It has a market for a good deal of its surplus power and operates by steam a disinfector, a clinker-working plant and a brick-making plant. It develops on the average 26.2 kilowatt-hours per ton of refuse. The combination of destructors and electrical generators represents advanced engineering ideas, and the results amply show their practical value. Further improvements are being constantly made, such as the recent installation of a 30-h.p. Bellis steam engine for operating a fan at the base of the chimney stack to increase the draft, and the addition of three marine-type, dry-back destructor boilers.

The destructors consist of 12 Horsfall cells. These are arranged in groups of six each, with three in each group placed back to back. Six Babcock boilers are placed between these groups, and also the new marine-type boilers. Economizers are provided in the main flue, and mechanical stokers in the furnace. Furnace blast was originally supplied solely by steam jets of the Horsfall type, but more recently the Bellis engine operating a fan blower has improved the draft. This engine takes some 30 pounds of steam per brake horse-power-hour.

The electrical plant is of the two-phase alternating type, and the engines driving the generators are of the horizontal Musgrave type, running non-condensing. There are three 300-kw. alternators and three 100-kw., direct-current dynamos, the latter being employed for lighting the works, exciting the alternators and supplying current to motors which drive nearly all of the auxiliary machinery. Two 5-h.p. motors are used for driving the economizer scrapers and four 10-h.p. motors for operating the mechanical stokers and coal conveyors. Besides lighting the place and other public buildings, a good deal of the electric power is used for pumping. There are five 20-h.p. motors driving centrifugal pumps and one 20-h.p. motor driving a deep-well pump. The amount of steam furnished to the brick-making plant has not been stated, but it must be considerable, for it is in operation most of the time in the day.

In the winter season the electric light load is heavy and the full output of the plant is used. During the midwinter holidays some 100 extra arc lights for street lighting are added to the regular plant. The returns from this plant indicate a profit sufficient to warrant its enlargement and the tendency is to improve its efficiency in every possible way.

The Shoreditch plant burns about 26,000 tons of refuse a year and over 6,300 tons of coal and supplies light, heat and power for the public baths, library and deep-well pumps. The disposal of the clinker is an important item here as elsewhere, and it continues to show a considerable loss each year. If this could be eliminated the showing of the plant would be much better.

The Bermondsey plant burns between 13,000 and 15,000 tons of refuse a year and 400 tons of coal. The power is used for generating electricity for lighting and steam used for heating the bathhouses and public buildings. At Woolwich a disinfector and brick-making plant are operated in addition to the generator of electric light for the buildings. Most of the destructors in the smaller places are of the old type, and few of them have been equipped with the most recent improvements. The results obtained from them have little bearing upon the larger problem of reducing the cost of destruction and increasing the output of power and electric light from a given ton of refuse. The average cost of each ton of refuse burned varies in the provinces and in London because of the difference in the price of labor. In London, however, mechanical appliances for economizing in handling and burning apparently more than offset any difference in higher wages paid.

The Value of Tail Rods.—A suburban railway company has as a part of its equipment two 1000-h.p. cross-compound condensing Corliss engines, the engines being both alike excepting that one has tail rods. The engine with the tail rods has been the more economical of the two, and has cost practically nothing for maintenance during the two years it has been running. A saving in steam consumption has also been one of the features of this engine with the tail rods, and it can be run at about 10 per cent greater capacity than the other. In the three years which the engine without the tail rods has run, it has worn out two sets of bull rings and the low-pressure cylinder has been worn down about 1 1/16 ins.

Abstracts from Foreign Contemporaries

Beck Arc Lamp.—The *Elektrotechnische Zeitschrift* contains an illustrated description of a new arc lamp in which the carbon is impregnated with light emitting substances and which burns with a long arc. The construction of the lamp is shown diagrammatically by Fig. 1. The carbons are arranged side by side in a slightly inclined position. One carbon is fixed, with respect to its longitudinal direction; the other being adjusted in position by means of the lever shown at the top. This lever is operated by means of an electromagnet, shown in the center at the top of the lamp. When no current flows the two carbons touch each other at their terminals at the bottom. When

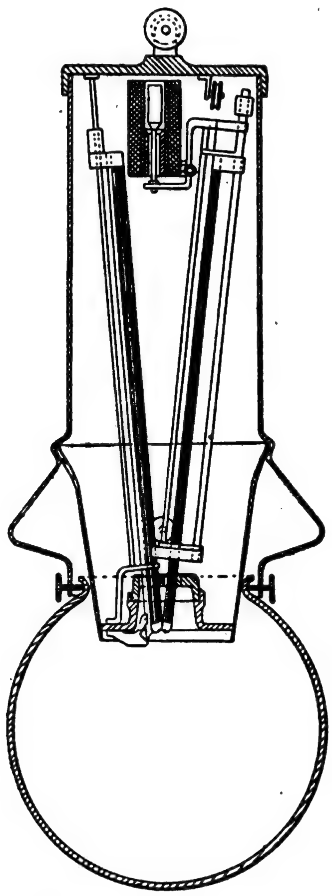


FIG. 1.—BECK ARC LAMP.

the circuit is closed the right hand carbon is deviated sideways and the arc is started. The deviation of the right hand carbon is limited so that a constant distance between the two carbons is maintained. The electromagnet is entirely closed and contains only a few windings through which the main current flows. The lower terminals of the carbons are surrounded by a cast-iron reflector, the inside of which is of white enamel. The left carbon (for direct-current mostly the positive carbon) has not an exact circular cross-section, but is provided with a rib, which is shown at the left, and by means of which it rests on a support mounted at the bottom of the reflector. Above the lower supporting surface there is provided a small chamber surrounding the carbon rib and protecting it from the air. The purpose is to let the carbon burn off in such a way that a fine point always remains at the end of the rib. This fine point is the point on which the left carbon rests. It is stated that it burns off very uniformly and slowly, so that the carbon electrode is fed downwards very gradually and uniformly.

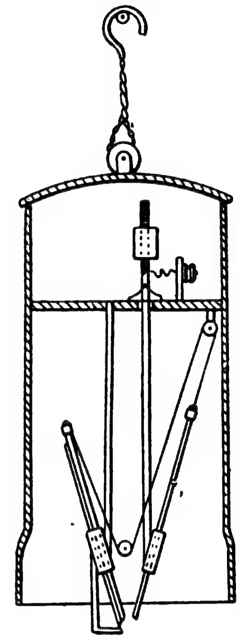


FIG. 2.—BECK ARC LAMP.

The support on which the fine terminal point of the carbon rib rests remains relatively cold. The right hand carbon, which has a completely circular cross-section, is fed downwards simultaneously with the left hand carbon by means of the mechanism shown in Fig. 2. The most economical current is stated to be 6 to 12 amperes for direct or alternating current for an e. m. f. at the terminals of 42 to 46 volts. Wedding has tested a direct-current lamp for 9.1 amperes at 44.2 volts, which gave without globe, 2469 hemispheric candle-power, corresponding to a consumption of 0.163 watt per candle. The maximum of illumination, which is 3800 candle-power, is perpendicularly below the lamp. Cored carbons are stated to be best. For the 9-ampere lamp the diameter of the positive carbon is 8 mm., that of the negative carbon is 7.5 mm. The length of the carbon is 330 mm. for the smallest type of lamp, which gives a carbon life of 8 hours. The lamps are built for carbon lengths up to 550 mm. For a carbon life up to 30 hours double lamps are used.

Electrical Resistance of Steel.—The May *Bulletin* of the Société d'Encouragement pour l'Industrie Nationale contains a short but interesting article upon the "Electrical Resistance of Steel." Following up some experiments made some time ago by Monsieur H. Le Chatelier, the author of this article—Monsieur P. Mahler—has carried out a series of tests on specimens of steel containing varying amounts of carbon, manganese, sulphur, phosphorus and silicon. Generally speaking, he has established the fact—which in truth is what might have been expected—that the more impure the steel, the higher is its electrical resistance. For example, in one of his sets of experiments he took five test pieces, varying from soft steel, with a breaking stress of 40 kilos. per square millimetre of cross-section, to hard steel with a breaking stress of 70 kilos. The percentage of carbon varied from 0.16 per cent. to 0.62 per cent., and of manganese from 0.70 per cent. to 0.80 per cent. The observed resistance was 14.6 microhm-centimetres for the soft steel and 18.0 microhm-centimetres for the hard steel. M. Mahler found that the total resistance varied in accordance with the formula $R = 10 + 7\,C + 5\,Mn$; where C is the carbon, Mn the manganese, and 10 the resistance due to the iron and to the other impurities, such as sulphur, phosphorus, etc. The 7 and 5 for carbon and manganese were the figures which M. Le Chatelier had found in his experiments. The coefficient 10 has been found by M. Mahler, and within the limits of his investigations the formula appears to give the resistance of any steel of known composition very fairly nearly. There are discrepancies, which are sometimes on one side and sometimes on the other, but in a number of cases the calculated resistance was found to be the same as that which was obtained by measurements. Perhaps the balance lies rather in the direction of the coefficient 10 being somewhat high, but this error is certainly on the right side. The ability to estimate the electrical resistance of steels of known composition within a reasonable degree of accuracy is highly important having regard to the increasing use of steel rails for conducting electricity, and it would appear that in samples of metal known to be more or less oxidized or more or less gaseous, the actual resistance is less than what might be looked for if the above formula is taken as a basis. This means that, at any rate, the probabilities are that a calculation of the resistance is more likely to err on the high than on the low side.

The Lentz Engine.—A neat type of engine, manufactured by Les Ateliers de Construction, H. Bollinck, of Brussels, is described in the London *Engineer.* The engine, which is of massive design, works with superheated steam of high temperature. The cylinders are placed tandem, and directly connected to each other so that one stuffing-box is dispensed with. One stuffing-box is placed between the two cylinders. Steam enters from the boiler at the bottom side of the high-pressure cylinder, and leaves through the exhaust valve, and then passes directly into the low-pressure cylinder, of which the admission valves are placed on the top, and the exhaust valves at the bottom. By this system it is claimed that the steam follows a rational and short course, and the important losses produced by radiation and condensation in the pipes

and receiver are by this means avoided. Joints in pipes are also dispensed with, and it follows that there will be no expense in maintenance in respect of these. Another point claimed is that the fall in pressure between the two cylinders is not so great in this case as it would be with piping and a receiver. One of the most interesting features of the Lentz engine is the valves. The admission valves are double seated, the interior seat being smaller than the other, the whole system being balanced. They are capable of lifting automatically should any water get into the cylinder. The valve seats are of such a shape that when the valves are closed they form a water-tight joint. The valve rods are fitted with a roller actuated by an eccentric on the gov-

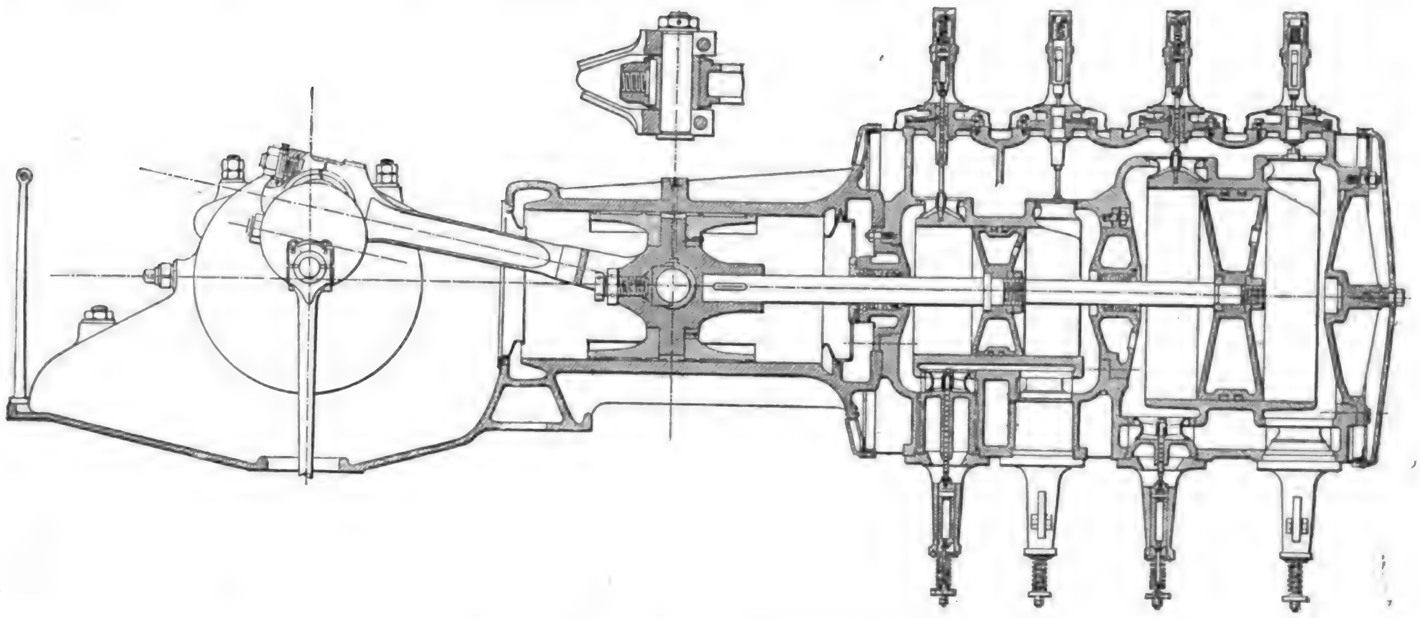


FIG. 3.—LENTZ TANDEM COMPOUND STEAM ENGINE.

ernor spindle on which are two eccentrics connected by two rods to the cams, against which the rollers of the valve spindles are kept pressed. The valve rods receive their motion from these cams, and the design of the latter is such that a rapid opening and closing can be obtained without any shock. The Lentz governor is said to be very sensitive. As will be seen from the illustra-

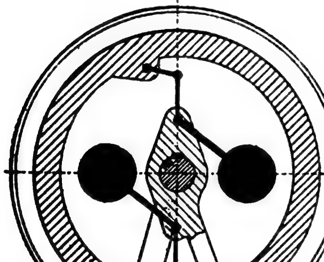


FIG. 4.—LENTZ GOVERNOR.

tion, the governor consists of a ring which acts as a sort of fly-wheel. There is a boss on the governor spindle, and on both the ring and the boss there is an arm, these arms being joined together by a circular coupling spring. The boss is oblong in form, and to it are pivoted the weight spindles, the ends of which are connected by links to lugs placed exactly opposite one another on the inside of the ring. As soon as an acceleration of velocity is about to take place, the inertia of the ring absorbs part of the load on the circular coupling spring, and the centripedal force is diminished. The weights immediately separate, and the valves are acted upon. Exactly the opposite to the foregoing happens when the engine tends to run slow. The variation of the amount of admission of the steam to the cylinder is said to precede any visible change of velocity. The effect of the inertia of the fly-wheel ring is only momentary, and disappears when the velocity becomes normal. The makers state that the governor acts so well that polyphase generators may be run in parallel without any fear of uneven loading. The governor can be so arranged that the speed of the engine can be regulated from the switchboard. The stuffing-box is also another interesting part of the engine. It is formed by a series of annular recesses in gun-metal rings, the rings having placed between them cast-iron rings, which are an easy fit on the rod. The recesses are filled with oil The first ring allows some steam to escape, the second one absorbs part of this escape, the third does the same, and finally the fourth ring allows no steam at all to escape. The small quantity of steam which is introduced at the moment of admission into the first two or three recesses returns to the cylinder during the period of expansion. The valve spindles have no stuffing-boxes. They are ground in their guides, and carry a series of small annular cavities, which retain a layer of oil mixed with condensed water. This arrangement is said to be particularly advantageous when superheated steam is used. The stuffing-box for the piston-rod, and also for the valve spindle, involve practically no metallic friction, and, for this reason, the makers assert that the loss of power due to these parts is small. It is stated that the variation in speed of these engines in any one revolution does not exceed 1.25 per cent. The makers have adopted a short stroke which is not much more than half what is usual in other engines of this type, and this allows of a considerable increase in speed without the piston speed exceeding about 4 m. per second. There is only one spring, and no delicate mechanism or dash-pot. Sight feed lubricators are employed for oiling the various parts of the engine.

Wireless Telephony.— Dr. Hugo Mosler contributes to a recent number of the *Elektrotechnische Zeitschrift* some observations made by him while experimenting in wireless telephony. The simplest arrangement of sending station is shown by Fig. 5 herewith, where B is a battery having an e.m.f. of about 25 volts, M is a microphone, and J an induction coil one secondary pole of which is connected to earth. The telephone used at the receiving station has one terminal connected to earth, while the other terminal is free. The telephone used by the author in his experiments had a metal box which was touched by the hand of the hearer. The use of antenna at the receiving station does not improve transmission. For good transmission it is preferable to connect at the transmitting station the free secondary pole of the induction coil with an insulated suspended coil S containing about 2.5 km. of copper wire. If both poles of the induction

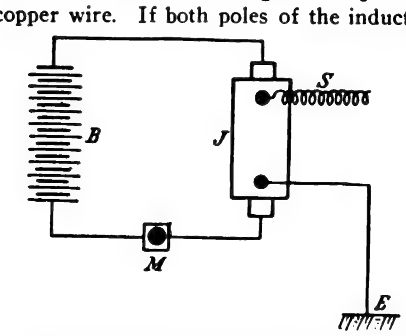


FIG. 5.—WIRELESS TELEPHONE SENDING STATION.

coil J are earthed, the transmission of sound is greatly weakened. On the other hand if both poles of the telephone are earthed at the receiving station good sound transmission results if the conditions are as indicated in Fig. 6. In this engraving A represents the earthed plate of the induction coil at the transmitting station; $B\ C\ D$ are earthed

plates at the receiving station, F is a telephone and E a switch, by means of which either plate C or D may be connected to F. With B and C connected to F no sound is received; but with B and D connected to F the transmission of sound is good. The author accounts for this by assuming that

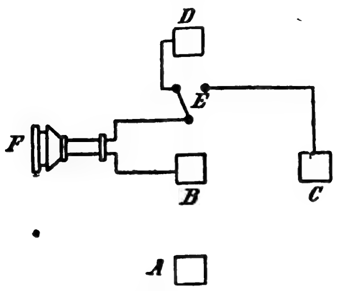


FIG. 6.—WIRELESS TELEPHONY.

periodic electrifications of the surface of the earth are propagated from the earth plate A of the transmitter. This propagation takes place in circles around A. In order to get good transmission, therefore, it is necessary to connect the telephone F with two points having different potentials. If B and

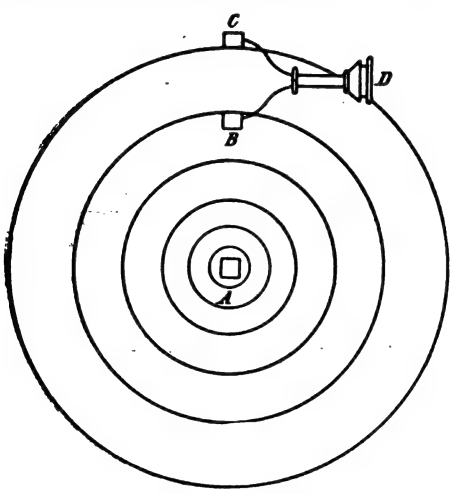
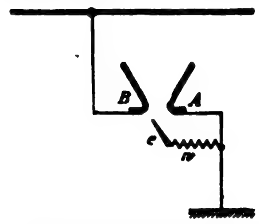


FIG. 7.—WIRELESS TELEPHONY.

C are about equally distant from A they have about the same potential, so that nothing is heard in the telephone D. In the experiments only one pole of the telephone was earthed, but a second earthed connection was made through the metal box of the telephone to the experimenter, who in this case was standing at a point D. Sound may thus be transmitted over several kilometers, especially over water, if induction coils with high transformation ratios and a microphone which can stand strong currents are used. For wireless telephony over greater distances, however, it is, of course, necessary to use ether waves.

Lightning Arresters—Alberto Dina contributes to a late number of *Elektrotechnische Zeitschrift* an illustrated article on various designs of lightning arresters with particular reference to the relay built by the Siemens-Schuckert Works. The most suitable length of air gap for relative low voltages of a few thousand volts is said to be three to four millimetres. All attempts to lengthen the air-gap by giving special forms to the electrodes, as for instance by giving them sharp edges, have proved unsuccessful, since after numerous discharges have taken place the sharp edges are destroyed. Artificial air-gaps have been introduced in many instances for the purpose of starting the discharge. Either the heat effect or the ionizing effect of the ultra-violet light of the stroke starts the discharge through the main air-gap. Fig. 8 shows such an arrangement in which Be is the auxiliary air-gap, and BA the main air-gap. A modification of this arrangement is shown by Fig. 9, in which three discharges may take place; first between ee, then between B and e and finally the main discharge from B to A. Further modifications of this scheme are, of course,



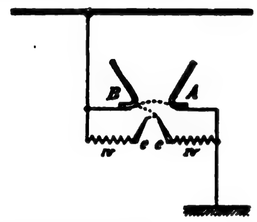


FIG. 8.—LIGHTNING ARRESTERS.—FIG. 9.

possible by using successive auxiliary gaps like that at ee, one below the other and with decreasing lengths of the gap so that the lowest and shortest gap is first acted on. This starts the discharge through the next one above and so on. The disadvantage of this arrangement is that the auxiliary air-gap must have a short length and is liable to be changed in time, and the wind may, moreover, blow the discharge from the main gap to the auxiliary gap, and it may remain where there are no special devices provided for extinguishing the arc quickly. The Siemens-Schuckert lightning arrester is shown by Fig. 11. The device makes use of a special circuit in which high frequency oscillations are produced. W is the damping resistance and $B\,A$ is the main air-gap. $C\,C^1$ are condensers, F is an auxiliary air gap, P

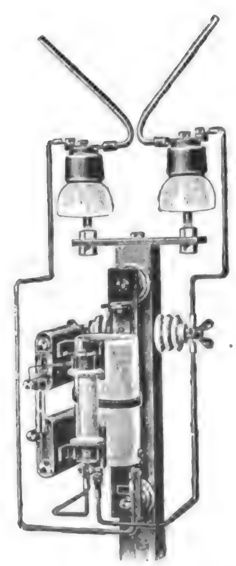


FIG. 10.—LIGHTNING ARRESTER.

the primary and S the secondary of a transformer. When the voltage at the plates of the condenser C (which is practically equal to the voltage between line and earth) reaches the value to which the air-gap F is adjusted, the condenser C discharges partly through the circuit $C\,F\,C^1\,P$, i. e., it transfers a part of its charge to the other condenser C_1, high frequency currents being produced. This discharge depends in no way on the methods by which the condenser C has been charged (that is, on the causes of the excessive rise of voltage in the line). The oscillating currents in the primary P

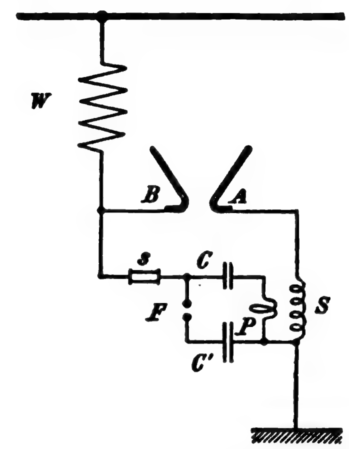


FIG. 11.—SIEMENS-SCHUCKERT LIGHTNING ARRESTER.

produce a high e.m.f. in the secondary S of of the transformer, so that now a higher voltage exists between B and A and the discharge from B to A is started. This higher e.m.f. does not affect the line. The main advantage is that there is no direct effect from the auxiliary air-gap F on the main discharge gap BA. It is, therefore, possible to enclose F in a suitable tube and place it at some distance from the main discharge. The apparatus is called a "lightning arrester relay." It is built with an air-gap $B\,A$ of 4 mm. for about 3000 volts effective current and with a gap of 3 mm. for about 2000 volts. Fig. 10 shows the relay in use with horn lightning arresters. A modification of the arrangement shown in Fig. 11 is given by Fig. 12. In this arrangement the condensers are placed in series instead of in parallel as in the former case. The arrangement, however, has the disadvantage that the condensers are always under tension; but, on the other hand, it has the ad-

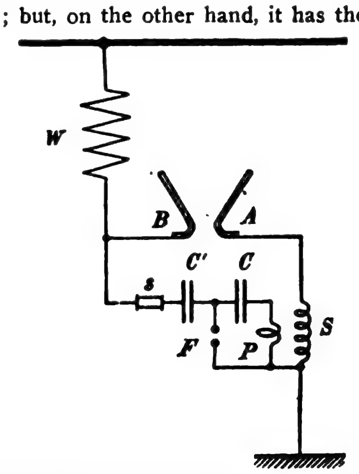


FIG. 12.—SIEMENS-SCHUCKERT LIGHTNING ARRESTER.

vantage that each condenser has to stand only part of the tension. For adjusting the auxiliary air-gap only the voltage of the condenser C has to be taken into account. For this reason this latter arrangement may be used for higher tensions. Fig. 13 shows an arrangement having many different

spark-gaps but requiring but one arrester. In this scheme no condenser is under tension for any length of time. If the arrester itself has not acted on the appearance of over voltage, it is at least probable one of the air-gaps, *f*, will get into action so that the condensers $C\,C^1$ are charged. This process of charging through a sparking distance cannot produce any considerable e.m.f. since the capacity of the condensers may be very small and are connected in series with the damping resistance *W*. Owing to the sensitive adjustment of the air-gap *F* of the oscillating circuit the condenser *C* begins to discharge at the beginning of the condenser charge, so that the arc, therefore, begins to discharge at once. The e.m.f of the secondary *S* does not any longer discharge through the oscillating circuit itself; since, however, the object of the relay is not to enlarge the gap but to start the discharge, a very small capacity γ is sufficient to cause a higher e.m.f. to be established between the horns of the arrester than that for which the arrester was adjusted. By this means the machine is protected by the high self-induction of the choking coils. There remains, however, the greater capacity *T* between the line and earth in series with the arrester and the resistance *W* which offers an easy return path for the oscillations passing from *S* to the arrester.

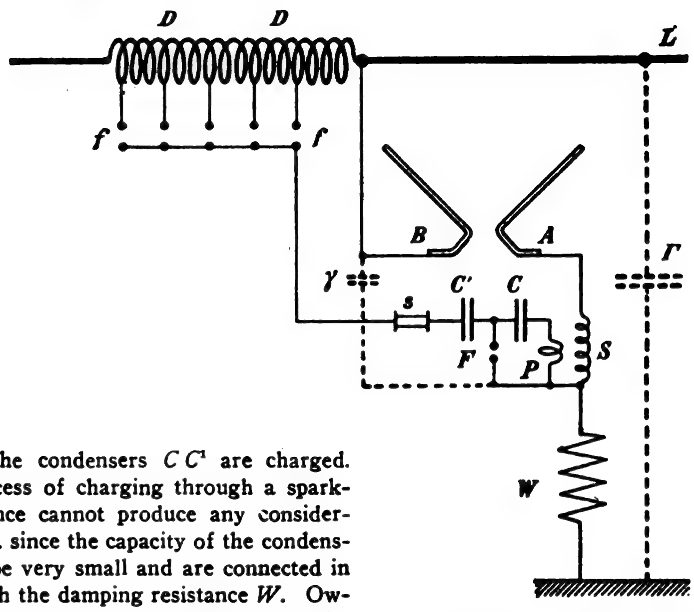


FIG. 13.—LIGHTNING ARRESTER.

Efficiency of Switches and Switchboards.—A. Boje contributes to the *Elektrotechnischer Neuigkeits-Anzeiger* an account of an extended series of tests on switches and switchboards. The station contained two 80-kw., direct-current dynamos, one of 160 kilowatts and two storage batteries each of 600 ampere-hours. The mean current of the machines and batteries during one year was carefully determined and the efficiency of the switches and the switchboards was then calculated for this mean current. The total energy given out during one year from the switchboard was 298,546 kw.-hours, the loss in the switchboard 2404 kw.-hours; hence the efficiency was 99.2 per cent. While this efficiency is high, yet the selling price of the energy lost during one year in the switchboard represents 20 per cent of the first cost of the switchboard. The author discusses means for decreasing this loss. He recommends strongly the avoidance of ordinary electromagnetic measuring instruments in switchboards, and the installation of precision instruments in spite of their higher cost, since the saving due to the decreased loss in only two years compensates for the higher cost. A great many experiments were made on the loss in movable contact surfaces. Fifteen different lubricating materials were tested and it was found that a certain fat which conducts the electric current reduced the losses in the contacts by 50 to 60 per cent. Other fats were not as good and some materials tested, like stearin, tallow, graphite, increased the contact losses. It is, therefore, recommended to lubricate the movable contact surfaces very slightly with a suitable fat. Stationary contact surfaces, for instance bus-bar connections, etc., also showed considerable losses. From a great number of tests with various thin plates placed between the two contact surfaces it was found that the contact loss can be slightly reduced by a thin sheet of tin-foil of 0.02 mm. thickness or of copper of 0.04 mm. thickness.

Some Recent Electrical Patents

Mercury Vapor Lamp.—In the construction of electric lamps of the mercury vapor type it is essential that some means be provided for breaking down the initial insulation of the space within the tube in order to start the flow of current through it. The devices hitherto employed for this purpose have involved the application of a high e.m.f or else necessitated the use of some magneto-mechanical arrangement for putting the electrodes momentarily into contact; the latter class of apparatus appears to be gaining in favor. A very simple arrangement of this class has been devised by Mr. W. R. Whitney, of Boston, Mass., in which the moving parts are all outside the lamp proper. This is illustrated diagrammatically by Fig. 1, in which 2 is the upper electrode, 5 is a carbon filament extending downward from the electrode to within a short distance of the mercury, 3; 7 is a glass support for the filament, 8 is a magnet coil and 12 is an automatic cut-out for this coil. The mass 3 is an amalgam of mercury and iron, so that it is capable of responding to the magnetic attraction of the coil, 8, when that coil is excited; the mercury and iron are then drawn up into contact with the carbon filament, as indicated at the lower right hand corner of the engraving, and the current is thereby started through the lamp. This

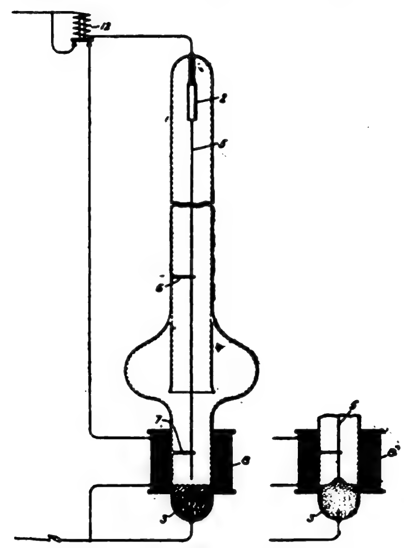


FIG. 1.—MERCURY VAPOR LAMP.

energizes the magnet of the cut-out, 12, which opens the circuit through the magnetic coil, 8, allowing the mercury to fall back away from the carbon filament and start the arc. The arc follows rapidly along the filament until it reaches the upper electrode, when the lamp is is full operation. Patent No. 792,639.

Contact Key for Alternating Currents.—An objection to the use of a contact-making and breaking device in a circuit carrying heavy current is the arcing that occurs between the active faces of the contact pieces when the circuit is broken. It is obvious that in the case of alternating current of symmetrical wave form, arcing at the contacts could be prevented if the circuit were opened exactly at the instant when the alternating e.m.f is passing through zero. Fig. 2 illustrates in simplified diagrammatic form an arrangement devised by Mr. Andrew Gray, of London, for accomplishing this, and Fig. 3 indicates a modification. In Fig. 2, the finger piece, *g*, when depressed holds the contact lever *d* against its anvil, regardless of circuit con-

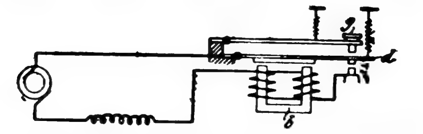


FIG. 2.—CONTACT KEY FOR ALTERNATING CURRENTS.

ditions. When the finger piece is released to open the circuit, the magnet *b* retains the lever *d* until the alternating current reaches zero, when the lever is free to be drawn away from the anvil by the spring. In Fig. 3, there are two contacts in shunt relation, one controlled by the key *g* and the other independently controlled by the arma-

ture *d*, which vibrates in unison with the alternations of the current, but cannot open the circuit as long as the shunt key contact is closed. Releasing the key leaves the cir-

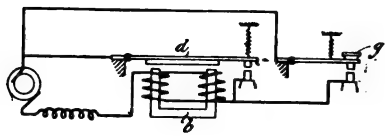


FIG. 3.—CONTACT FINGER FOR ALTERNATING CURRENTS.

cuit dependent on the armature contact, of course, and it is opened at the next succeeding zero point. Patent No. 702,020.

Alternating-Current Motor Control—One of the most interesting characteristics of the alternating-current commutator motor is revealed in a patent recently issued to Messrs. G. Winter, of Vienna, and F. Eichberg, of Berlin. The patent relates to the use of self-exciting generator features of the repulsion motor; the control circuits are shown in Fig. 4 herewith. The armature winding, indicated by the circle *B*, is close-circuited by two brushes bearing on the commutator in the usual manner and connected electrically by a conductor of negligible resistance. In line mechanically with the brushes is an "inducing" field winding, *A*, and in mechanical quadrature with this winding is an "exciting" field winding, *C*. For normal operation the two windings are connected in series; the armature winding is in inductive relation to the field, as usual. When it is desired to stop the motor, the field windings are disconnected from the supply circuit, of course, and close-circuited in series with each other and the adjustable resistance, *R*, but with their relative connections reversed; this is for the purpose of braking the motor electro-dynamically. In this condition the magnetic flux encircled by the exciting winding induces an electromotive force in the armature windings to which the brush position is favorable, and the current flow-

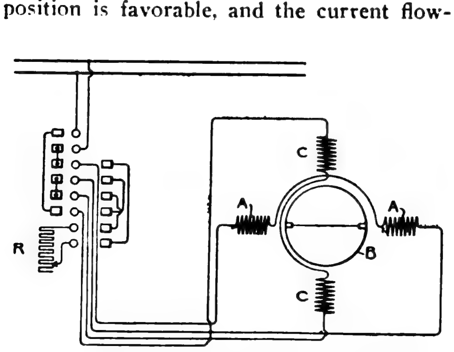


FIG. 4.—ALTERNATING-CURRENT MOTOR CONTROL CIRCUITS.

ing in the armature winding strengthens the magnetic flux within the exciting winding, thereby braking the armature. Patent No. 792.103.

CENTRAL STATION ENGINEERS

IX.

Henry Harbison Sinclair.

Henry Harbison Sinclair was born in Brooklyn, N. Y., on December 22, 1858. His education was begun in the public schools of his native city, after which he entered the Military Academy at Bethlehem, Pa. At the age of 15, however, he ran away from home and shipped on a sailing vessel bound for California, quitting the sea three years after with papers as a second mate. When 18 years of age he took up a scientific course at Cornell University, which he was compelled to abandon owing to failing health. He then entered the New York shipping firm of his father, afterward becoming the latter's partner under the firm name of N. B. Sinclair & Son. In 1885 Mr. Sinclair abandoned business to study law in the firm of Hill, Wing & Shoudy, applying himself to admiralty practice. This, too, he was compelled to relinquish owing to failing health and in 1887 he moved with his family from New York to Lugonia, Cal., a settlement adjoining the town of Redlands, where he engaged in orange culture. For several years Mr. Sinclair led the quiet life of a horticulturist, gradually regaining his health and a longing for active commercial existence. When, therefore, the opportunity came in 1892 to develop a water power plant on Mill Creek, east of Redlands, which should supply electric energy to his city and the surrounding territory, he was quick to see its possibilities and to turn them to advantage. He assisted in the organization of the Redlands Electric Light & Power Company, becoming its president and general manager and continuing the active head of the company until it became the property of the Edison Electric Company. At the time of its transfer the Redlands Company had in successful operation two plants on Mill Creek and a third under construction, having pioneered 10,000-volt transmission, and about to pioneer the discharge of water from a vertical height of 1962 feet into the impact wheels of power house No. 3. This plant has been in operation since March, 1903. In April, 1897, Mr. Sinclair organized the Southern California Power Company, which was transferred to The Edison Electric Company, of Los Angeles, the next year, Mr. Sinclair becoming a director of the latter company. Subsequently there were organized the Lytle Creek Light & Power Company, operating on Lytle Creek, San Bernardino County, Cal., the Mountain Power Company, operating on Santa Ana River, the California Power Company, operating in Kern County, and owning water rights for the development of nearly 100,000 horse-power, and the Kings River Power Company, with water power rights in San Joaquin County. Mr. Sinclair was actively associated in the formation of these companies which afterward became a part of the Edison system.

HENRY HARBISON SINCLAIR.

In the fall of 1901 Mr. Sinclair removed to Los Angeles, having in the meantime become third vice-president of The Edison Electric Company, in charge of all the company's water power development. Mr. Sinclair became the general manager of the company early in 1903, devoting his energies to the details of the expanded corporation. Incessant work again told on his health, and he was obliged to take a prolonged trip to Honolulu and the South Sea Islands, Japan and the Philippines. The war in the Far East, however, changed his plans and he began his return voyage after six months' absence. In 1901 Mr. Sinclair assisted in the organization of the San Bernardino Valley Traction Company, an interurban electric road uniting the cities of San Bernardino, Redlands and Colton and the town of Highlands, operating some 28 miles of standard gauge single track. Mr. Sinclair's company is among the largest electric companies of the United States, supplying electric light and power to 18 municipalities situated in five counties.

NOTES.

New York State Independent Telephone Association held its fourth annual meeting at Albany, June 16. In addition to the reading of papers, the convention passed resolutions to the effect that the State authorities be requested to install independent telephones in the various departments, buildings, etc., so that communication with such departments, etc., might be available to patrons of independent exchanges.

International Association of Municipal Electricians has decided to change the date of its coming convention at Erie, Pa., to August 23, 24 and 25, instead of August 29 to 31, inclusive. Reference was made in this column last month to the excellent character of the papers to be read.

The Southern Hardware Jobbers' Association held its fifteenth annual convention at Hot Springs, Va., June 6 to 9, inclusive. The meeting was conspicuously satisfactory in all particulars; the papers were on live topics and able in character, and the entertainment features left nothing to be desired.

Evening Courses in Physics and Electrical Engineering.—The Polytechnic Institute of Brooklyn announces for next fall a series of lectures on "Electric Transportation" as one of the evening courses in electrical engineering. These lectures will be delivered, beginning October 10, by Messrs. Armstrong, Barstow, Bliss, Calderwood, Doyle, Lardner, Mailloux, Moffatt, Perrine and Stott, all of whom are prominent practising engineers.

Reduction in Price of Current in New York City.—The New York Edison Company announces a reduction in the price of current from 15 to 10 cents per kilowatt. Power rates vary accordingly. No charge is made for incandescent renewals or arc lamp supplies, and all incandescent lamps and arc lamps that have been cut off temporarily or otherwise and all 16-c.p. incandescent lamps that have been replaced by smaller sizes may be restored to service without effect upon the charge.

Tired of Municipal Ownership—A recent special dispatch from Monroe, Mich., says: "The Monroe City Council has apparently become sick of owning a municipal lighting plant. Some two weeks ago a proposition was sprung by City Surveyor White to lease the plant for ten years. Since that time other proposals have been presented and the council at an informal session decided to hear further propositions. The Detroit, Monroe & Toledo Company also made a proposition to furnish power, and this seems to be the most feasible one, since they have plenty of current. A full report will be made by a committee. Monroe has had municipal ownership for five years."

American Institute of Electrical Engineers held one of the most successful and satisfying conventions of its history at Asheville, N. C., June 19 to 22, inclusive. The papers were of a much higher average merit than usual and the proceedings passed off with commendable smoothness. The only departure from the programme as originally laid out was the holding of a short extra night session to dispose of a few papers that could not be given attention at the regular morning session on account of the length of discussions at that session. The lateness of the date of the convention precludes any attempt to publish a report of the proceedings in this number.

Municipal Plant in Oklahoma.—The Union Light & Power Company, of El Reno, has finished the municipal lighting plant at Anadarko, Oklahoma, and turned it over to the city. The plant was built in connection with the water works lately installed by the United States Government engineers, from the proceeds of the sales of the town and city lots at the time of the opening in August, 1901, the sales of these lots being reserved by the Government for the purpose of municipal improvements. The electric lighting plant consists of a tandem-compound McEwen engine 12 by 20 by 16, running at 250 r.p.m., direct-connected to a 110-kw. three-phase Bullock alternator. The street lighting system includes the Jandus alternating-current series arc lamps. The plant is in charge of Mr. A. C. Loudermilk, superintendent, and Mr. Charles Tomlins, chief engineer.

A 10,000, H P. Steam Turbine Installation.—Two steam turbine-generator sets of 10,000 horse-power are being installed at the Rhenanian Westphalian electricity works; these are the largest turbine sets, and in fact the largest stationary engines, in the whole of Europe. Each unit comprises a turbine running at 1,000 r.p.m., an alternating-current generator capable of 5,000 kilowatts at 5,000 volts and 50 cycles per second, and a direct-current generator of 1,500 kilowatts, giving 600 volts. The turbines are operated from a central steam plant. The whole set is 20 metres in length and weighs 190 tons, of which 9.4 metres and 107 tons apply to the turbine. The maximum height of the turbine above the floor is 2.6 metres, and the maximum breadth is the same. The turbine is of the Parsons type and has only two bearings, one of which serves also as bearing for the alternator. The governor is made to regulate to within 1 per cent. for variations in the angular speed, with fluctuations in the load as high as 20 per cent., while the maximum variation in the number of revolutions, between no load and full load, is not to exceed 5 per cent.

Power Development in Tennessee—The big project in the erection of the 36,000-h.p. lock and dam power plant at Hale's Bar in the Tennessee River is considered an assured fact. Messrs. C. E. James and J. C. Guild, the promoters of the scheme, have been in New York, where they completed the details concerning the financing of the scheme. It is announced in this connection that as soon as the plant is erected several new manufacturing plants will be erected at Chattanooga, one of them having a capital stock of over $1,000,000. The promoters will apply for a charter with $3,000,000 capitalization. The following will be the incorporators: C. E. James, J. C. Guild, J. C. Sims, R. H. Williams and George D. Lancaster. The plant will be located 12 miles from Chattanooga. The dam will be built of cement and stone, being 57 feet at the base, 9 feet at the top and 35 feet in height. The gates will cost $150,000 and will be furnished by the Government. The power plant will be located on the east side of the river and will be 60 by 30 feet in dimensions and 57 feet in height. Thirty-six turbine wheels will be employed to drive twelve generators.

Electricity on Board a German Warship.—The liner *Preussen*, which was recently attached to the German Baltic marine station, has a displacement of 13,200 tons and a speed of 18 knots, the output of her engines being 16,000 horse-power. Her equipment comprises four quick-firing guns of 28 cm. gauge, fourteen 17-cm. quick-firing guns and twelve of 8.8 cm. gauge; twelve 3.7-cm. machine guns, eight machine rifles and six torpedo launching tubes. All the rooms as well as the upper deck are lighted by incandescent lamps. For use in connection with the scouting service in battles, and also for signaling to a distance, there are used four large projectors, of 6,000 nominal candle-power each.

Electric motors are used for conveying ammunition from the ammunition chambers to the guns, for moving the rotating gun turrets, handling coal, lowering and hoisting the large boats, operating the machine tools and refrigerating plant, as well as for driving numerous fans of different sizes, which are installed in all the rooms of the ship.

The apparatus for the transmission of orders from one part of the ship to another, as well as for communication between different ships or from land to ship, the medical outfit of the infirmaries, instruments for indicating the depth, etc., are all operated by electricity.

Time Required to Start a Steam Turbine—At the recent Scranton meeting of the American Society of Mechanical Engineers, Mr. A. S. Mann presented a paper giving the result of observations on the time required to start a Curtis steam turbine. The turbine is of 1500 kw. capacity and is supplied from boilers which also supply steam for other purposes; upon starting up the turbine it is necessary, however, to pass from the condition of slow fires to forced fires. The time observed was that from sounding a whistle calling a scattered force to stations, to the time when the turbine was cut into circuit. Three or four pumps must be used in starting off each pair of turbines, and also an exciter driven by a small steam engine. The record book shows that of 43 calls for sudden starting up, 10 starts were made in 2½ minutes, 18 in three minutes and 15 in 3½ minutes. In a number of instances when all of the auxiliaries were in motion, the turbine was started and connected to line in from 45 seconds to 1½ minutes. Two starts in 45 seconds were made on the turbine when it had stood for 24 hours with the throttle valve shut, but with a slight leakage past the seat. After the throttle valve is off its seat it does not require more than 30 seconds to bring a turbine up to speed. The author states that to start a large steam engine from a cold state requires from 12 to 15 minutes and from a hot state 5 minutes.

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CONTENTS.

The Consulting Engineer and the Small Central Station.

Although it is true that many of the most lucrative pieces of work which fall to the consulting engineer are those in which things are done upon a great scale, there is still a field for the practice of thoroughly good engineering in connection with the smaller enterprises like the moderate-sized central station, the isolated plant and the small telephone exchange. In fact, it is a question if in some cases the limited resources of the small plant do not call for a greater degree of skill in meeting emergencies or practising expedients to make the business grow and pay than in the installations backed by millions in capital and surrounded by the facilities and conveniences of a great city.

It requires but a short study of different small central stations operating under modern conditions to show that remarkable differences exist among them in reference to the cost of operation and earning power, to say nothing of the diversity of equipment found. To cite a recent instance, the gross earnings per capita in those Massachusetts central stations serving less than 10,000 inhabitants last year varied from 60 cents to $5.14, and the ridiculous figure of 10.4 cents was reached in one case, if the returns can be considered correct. The gross earnings per ton of coal burned by the same stations varied from $12.10 to $35.50, showing some remarkable contrasts scarcely to be expected in so small an area as that occupied by the Bay State. Even the larger stations were notable for the variation in operating results obtained. Such differences as these, and Massachusetts is but an example of what prevails in many other sections, point to the need of a more thorough study of electric lighting economics, and the consulting engineer is certainly the exact man to meet the situation, if anyone can meet it.

The manager of a small central station seldom has the time to make the specialized comparisons of data which determine the final engineering and commercial efficiency of his plant as compared with another affected by somewhat similar conditions. Between keeping his customers satisfied and trying to show a dividend balance through careful operation and close attention to the securing of new business the manager of the small plant has little opportunity to go afield for the material which is so readily acquired by the consulting engineer paying special attention to comparative power station economy. Further than this, a disinterested and unbiased expert examination is almost certain to bring out a number of valuable operating criticisms and suggestions which the daily routine of central station management often fails to disclose. Something more than ordinary operating activity is needed properly to co-ordinate the discrepancies between plants which are doing the same general kind of work in the same general class of territory, but which for one reason or another, do not show similar results. The mere existence of a town boundary line is scarcely a sufficient reason for a jump in the ratio of operating expenses to gross earnings of from 50 to 85 per cent.

Doubtless many small central stations have in the past hesitated to pay the cost of expert advice through lack of ready means available for that purpose. A little consideration, however, of what has been done in larger work will often show that the lasting benefits of expert engineering far exceed the specialist's fee. Of course engineers are not lacking, as there also are bankers, to whom a small proposition does not appeal, but it is a great mistake to decide that expert advice cannot be had in a plant simply because it is a small one, and at reasonable price. And lastly, there are unworked possibilities in the community of interest idea, where two or more small plants jointly employ a consulting expert to analyze their economic production, to their mutual benefit and lessened individual expense. From the standpoint of the engineer the small plant is seldom worth neglecting as a client, and from the standpoint of the central station a little sound advice from an experienced analyst is nearly always worth a great deal more than it costs.

Motor-Operated Valves.

The recent accidents to large water mains in New York and Boston, resulting in the former case in the paralysis of subway traffic for many hours, and in the latter, in great inconvenience in the Washington Street Tunnel construction, indicate strongly the importance of equipping trunk line underground valves with electrical means of closing in preference to the slow and laborious hand operation at present so largely employed. Considering the costliness of such accidents in all their bearing upon complex urban life, it is singular that municipalities have as yet taken so little advantage of the experience gained in the use of motor-operated valves under all sorts of trying conditions by those who have had

the foresight to adopt them. The matter of first cost is not to be weighed seriously against the loss which often follows the bursting of a single 36-inch main, and the operating expenses are certainly insignificant when the saving in labor is duly appreciated.

Small motors are now on the market capable of performing any task in the way of valve closing, which either ordinary or emergency service demands. In the power station the ability to close important steam valves quickly from a distance is of great value in cases where steam pipes have burst, for many times the discharge of steam is such that no employee can reach the point where the valve is located. Although direct-current motor-operated valves are open to some objection for service around steam piping, it ought to be possible to apply the induction motor to such work with success, in view of the severe service which such motors are undergoing in all sorts of damp, dirty, hot and fume-sodden places. In fact the induction motor would also seem to be the ideal machine for the operation of water works and gas main valves underground, especially when the soil is frozen. Pipe galleries may isolate the effects of a break, but the real point is to stop the flow as soon as possible after rupture occurs, and for saving valuable minutes and in assisting in the speedy location of breaks in such cases the motor-driven valve deserves much more extended use than it has received.

Window Illumination.

Perhaps there is no branch of artificial lighting which offers a better field for the practice of original ideas than does the illumination of show windows. So widely do the conditions vary as to the kind and quantity of merchandise displayed; so different are the exhibit spaces, shapes and surroundings, and so diverse the color schemes found in shop windows, that it is really a specialist's task properly to design a modern window display, including that vital means to an end—the lighting arrangement.

The principal technical requirements of window lighting are simple in themselves. All that is needed is that the goods displayed shall stand out boldly against a suitable background; that the illumination shall be brilliant enough to attract the observer's attention to the goods, and even enough to enable the spectator to see all parts of the merchandise exposed, with clearness and without too much shadow. In common with all other forms of lighting except sign work, the equipment for producing window illumination must be so disposed as to attract no attention to itself, if the maximum effect of the displayed wares is to be secured. This principle is so often violated that central station men should lend their influence to the better disposition of equipment, which, otherwise in the hands of inexperienced customers, is likely to be grossly misapplied.

It is scarcely necessary to point out to technical men the superiority of electricity over all other illuminants for window work, but there is still great need for a more general appreciation on the part of the public of the advantages with which it is peculiarly endowed. Here again is a plain duty for the central station man, and one which he is usually not slow to improve. It is an undisputed fact that the cleanest and most artistic window display work now being done is accomplished by electricity alone. Look at any shop window lighted by Welsbach gas mantles after the first few weeks of glaring splendor have passed. A comparison of the ghastly illumination of such an installation with the even, brilliant, soft light of a well-designed electrically equipped window, emphasizing the differences to one's customers, is usually effective. There are object lessons of this kind in almost every city and town of commercial importance.

Considering the injurious effects of the gas-vitiated atmosphere upon delicate fabrics, bric-a-brac, polished silverware, books and other expensive merchandise, it is difficult to see why any other illuminant except electricity should be selected. It is to the central station's advantage to make a rate for window lighting during the evening hours that shall be almost irresistible to the progressive merchant, for, as in the case of the illuminated sign, discussed briefly last month, the business occurs at a time when the plant needs greatly to increase its output, or rather, to keep up its production. Towns which enjoy attractive window lighting on the principal streets during the evening are certain to benefit indirectly through enhanced reputations as live centres of population, and although the larger cities do not need this sort of advertising particularly, the result of a heavy window load is certain to be profitable to both the community and the merchants, while the central station reaps the benefit of the progressive policy.

A point often overlooked in electric window lighting is that more can be done at small expense than would appear at first sight. The use of mirrors and reflectors is well worth considering in most average cases; it is not necessary to install a great number of high powered lamps as a rule. A recently equipped jewelry store window containing twenty-one square feet of display space was found to contain forty-two 16-c.p. and thirty 8-c.p. lamps, or over 43 candle-power per square foot. The results were naturally most brilliant, but there is no question that the use of several lamps of the Nernst or Meridian types would have given quite as good or better service and at far less cost. There is always a point where the illumination ceases to be an auxiliary to the display of goods, and becomes inherently of chief interest. Such a point had long been passed in the case just cited.

No window installation is complete without attention having been paid to the fire risk of the wiring and arrangement of equipment. Care in the use of lamp bulbs around inflammable material is one of the first requisites; the very flexibility of electric lighting opens the door to possible misuse and danger.

Electricity in the Drug Store.

An attractive field for the sale of central station current, and one which has by no means been over-exploited as yet, is found in the retail drug store. Of course, the use of electricity for lighting displays, signs and general illumination has found favor in the domain of the druggist as well as elsewhere, but comparatively little, apparently, has been done thus far to push the small motor into useful places in the apothecary's shop.

Each summer, however, the uses of the small motor grow wider, and at the present time many druggists' establishments are equipped with electric fans, particularly in the vicinity of soda fountains, while others are adopting motors to operate milk shake machines, to drive the cream freezers, ice crushers, small lathes, special grinders, moving advertisements in the windows, and the like. A little study of the possibilities in this direction by central station men is likely to be fertile in results, for the manufacturers of small motors stand ready to produce a practical design to drive any sort of commercial machinery that the druggist employs. In these days of close profits, new business, even in the smaller fields, is worth investigation, for in the aggregate it is likely to be highly profitable.

HOW TO MAKE AN ELECTRIC BUCKBOARD.

BY J. C. BROCKSMITH.

The Motor.

In last month's article complete information and drawings were given for the running gear. It is the purpose of the present article to describe the motor with which to drive the buckboard.

The motor is a four-pole machine having a circular yoke of soft cast steel in one piece with the poles. It is provided with cover plates of aluminum alloy, which completely encase the working parts. All the motor bearings are of the steel ball type in order to reduce friction and wear to a minimum. The winding is of the series type for 80 volts and the speed under full load and voltage is 2800 to 3000 r.p.m. The maximum brake horse-power is about 1½.

Fig. 10 is a vertical section of the complete motor which shows the working parts of the motor in their proper position. This view brings out the construction of the bearings, commutator, brush holders and also the reduction gearing upon the sprocket shaft. It will be noted that the field cores are set somewhat off the center of the yoke, which allows for the space taken up by the commutator, and permits of the use of cover plates, which are alike, and therefore require only one pattern. The large central opening in the shell is bored and threaded to receive caps which when screwed on completely encase the motor. By removing the cap at the commutator end the brushes and commutator may be inspected without disturbing any of the other parts. The size of brushes used is ⅜ x ⅝ x 1 inch plumbago.

The counter-shaft, which carries a sprocket on one end for the chain drive, passes through the motor between the two lower field coils and has a 94-tooth, 20-pitch B. & S. gear keyed on the opposite end; this meshes with a 15-tooth, 20-pitch pinion made of tool steel and hardened in oil. This makes the distance between centers 2.725 inches.

Fig. 11 is an end elevation of the field frame and armature core. The bore is 3 9/16 inches, and the core is 3½ inches in diameter and has 18 round slots 13/32 inches in diameter. These discs are a standard size in use by one of the leading electrical manufacturing concerns and can be purchased from stock, or they can be produced by the builder by the process of drilling the slots already described in connection with previous small motor designs.

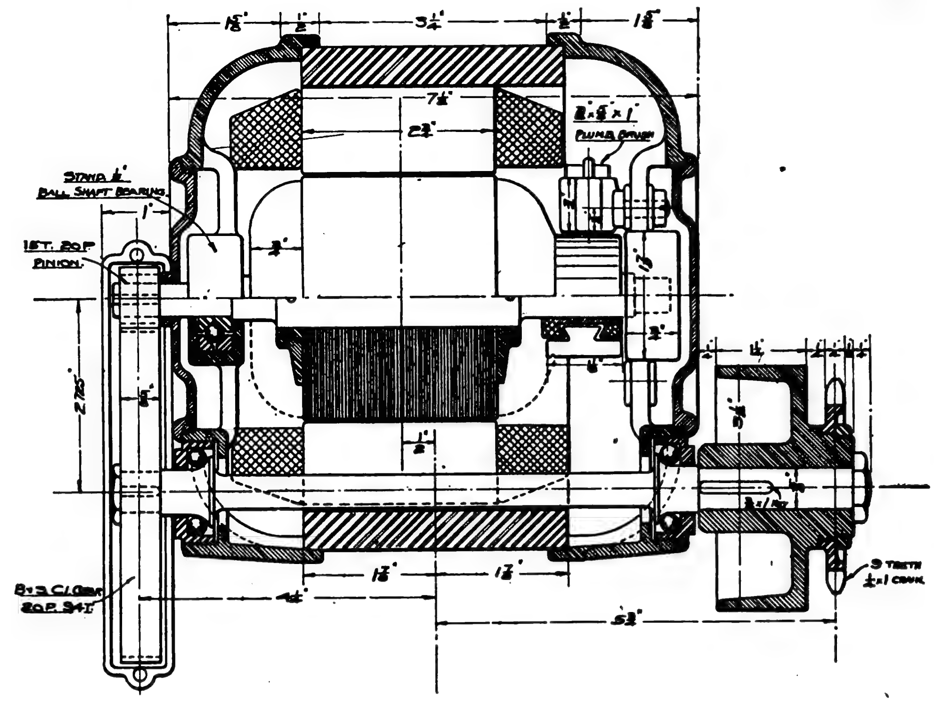


FIG. 10.—VERTICAL SECTION OF COMPLETE MOTOR.

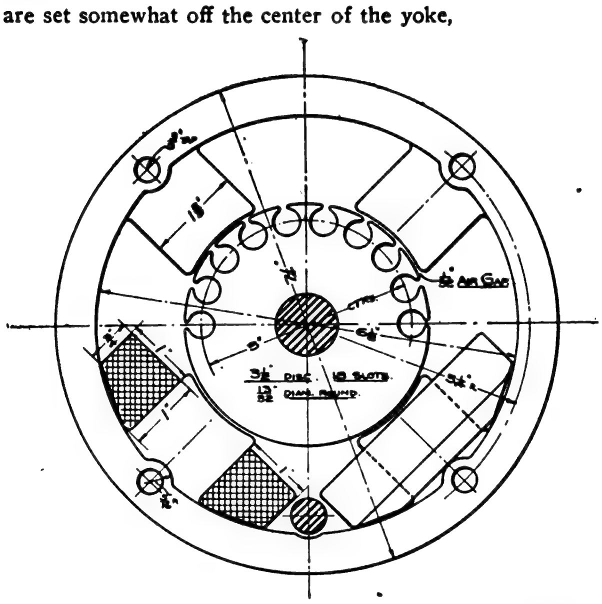


FIG. 11.—END ELEVATION OF FIELD AND ARMATURE.

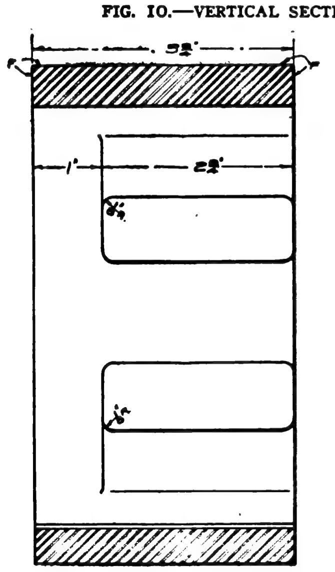


FIG. 12.—SECTION OF FIELD FRAME.

Fig. 12 is a section of the field casting, which shows the width of the yoke and the offset of the poles. No pole shoes are used, the field coils being simply slipped over the poles and retained in position by means of hard wood wedges driven in between the core and the coil. At four points around the circular yoke, holes are drilled and tapped for ⅜ x 2-inch hexagonal cap screws, which serve to fasten the bearing shells to the field frame. In finishing the field casting the polar space is bored out and the ends of the circular yoke faced off. The outer surface of the yoke also should be trued for a distance of about ¼ inch from each end, so as to afford a true seat for the bearing caps, which must be bored on their inner surfaces to fit the finished portions of the yoke.

Fig. 13 shows the details of the cover plate both in elevation and section. It consists of a curved shell, which covers the field coils, and in the center of which is the case for containing the ball armature bearings. This is supported from the wall of the shell by means of four radial arms,

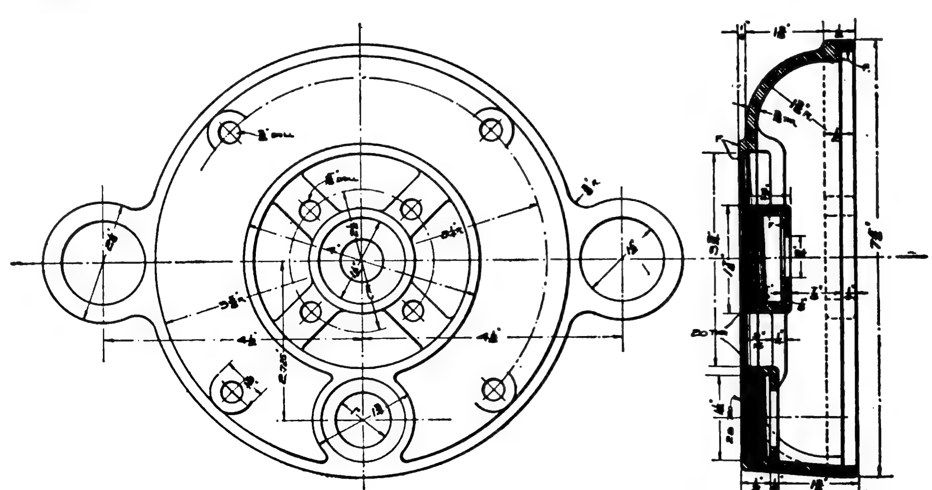


FIG. 13.—END VIEW AND SECTION OF COVER PLATE.

which also serve to support the brush holders, for which purpose they are drilled with 5/16-inch holes.

A circular boss is located 2.725 inches below the center of the armature shaft,

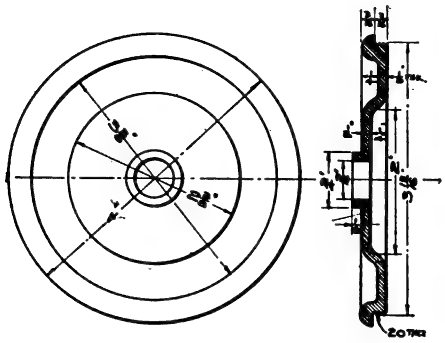


FIG. 14.—DETAIL OF COVER PLATE CAP.

and is bored and threaded for the tool-steel ball cups forming the counter-shaft bearings. This center to center distance must be exact for upon this depends the proper meshing of the gears. It is better to err on the side of having it a little full rather than scant. The case for containing the armature ball bearings is to be bored and threaded to suit the steel races, the bore being, of course, exactly concentric with the finished portion on the inner periphery of the shell which fits the field frame. The armature bearings are of the "grooved shaft ball bearing" type, which can be obtained ready made in standard sizes, of which this is one. They consist of three hardened and ground tool-steel races and a set of 12¼-inch balls. One of these races is in the form of a spool which fits the shaft snugly, while the other two fit the case, one being threaded for the purpose of adjusting the bearing.

Fig. 14 is a detail of the cap for closing the central openings in the cover plate. Two such caps are necessary, one having a hole in the center for the armature shaft to pass through, while the one at the commutator end is left blank. Both these caps, as well as the cover plates proper, are intended to be cast of aluminum alloy containing 25 or 30 per cent of zinc.

Fig. 15 shows the details of the armature and counter-shafts. The armature shaft can be conveniently made from a piece of ⅞-inch, cold-rolled steel; if care is taken in centering the piece, the middle portion will not require turning. The shaft is drilled for pins to be driven in after the core discs have been slipped on and the cast end discs have been pressed into place.

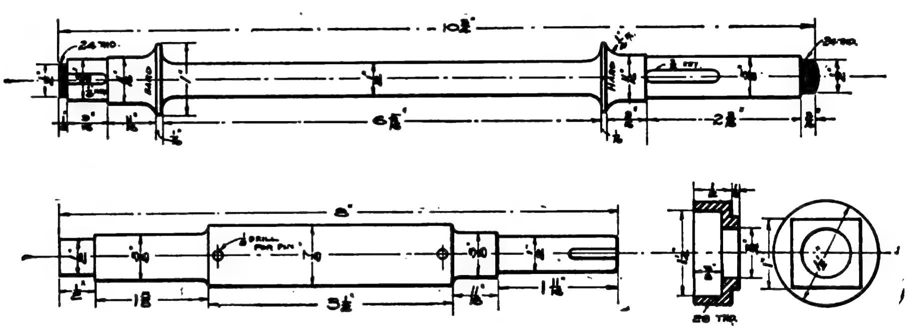


FIG. 15.—DETAILS OF ARMATURE AND COUNTER-SHAFTS.

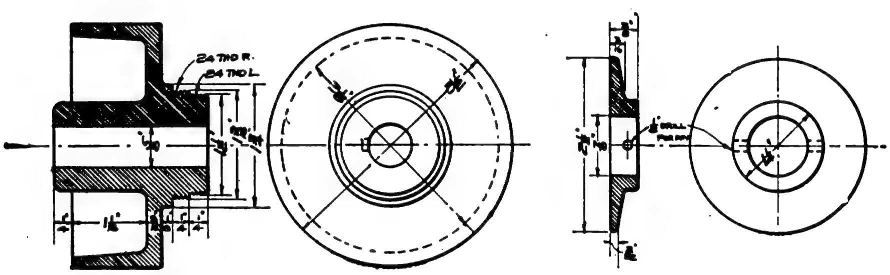


FIG. 17.—DETAILS OF BRAKE DRUM AND ARMATURE END DISC.

The counter-shaft is intended to be turned from a bar of 1-inch annealed tool steel, after which the cones are hardened. An easier but not so substantial construction is to use ½-inch cold-rolled steel with cones of tool steel pressed on and pinned in place.

Fig. 16 contains the details of the commutator and brush holders. The commutator can be most conveniently made from a phosphorized copper casting turned to the size shown and then sawed into 18 equal segments by means of a No. 23 screw-slotting cutter mounted on a mandril in the lathe. The segments thus obtained are built up with mica insulation equal in thickness to that of the cutter, and are clamped in a brass sleeve and nut having flanges undercut at a 60-inch angle. The brush holders are of cast brass; the slot for the brush can be cored very nearly to size and filed to a smooth finish. The brush should slide freely in its holder, but without play. The brushes should be of plumbago ⅜ x ⅝ x 1 inch, copper-plated, and each should be "pig-tailed" to its holder with some flexible bare copper wire. The springs are contained in a lug cast on the brush holder and are made up of No. 19 "Helmet" bronze wire, which is coiled on a mandril so as to be about 5/16 inch outside diameter. The insulation for the brush holders consists of fibre washers and some small fibre bushings, the dimensions of which are indicated in the drawing.

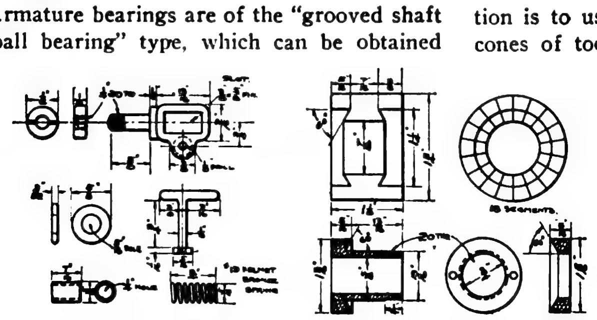


FIG. 16.—DETAILS OF COMMUTATOR AND BRUSH HOLDERS.

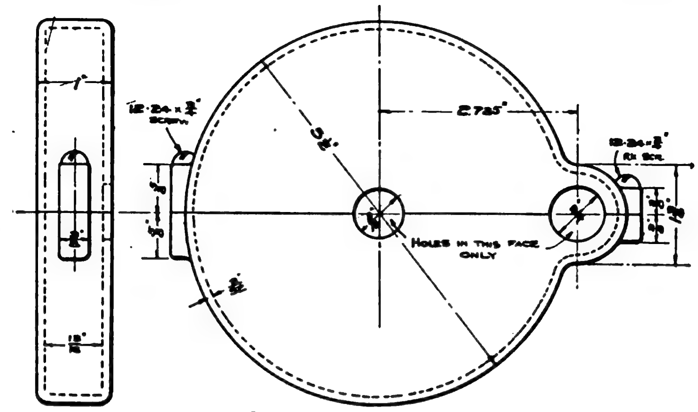


FIG. 18.—DETAILS OF GEAR CASE.

Fig. 17 shows the details of the brake drum and the end discs for the core. Both these parts can be cast of alzinc and are preferably finished all over.

Fig. 18 is a detail of the case for enclosing the motor reducing gears; this can be cast from alzinc and finished bright to give a good appearance. A half pattern will do, of course, as both halves of the case are alike. This case is intended to be partially filled with a heavy oil to reduce noise and wear of the gears to a minimum. The addition of some graphite in the oil also helps.

Fig. 19 represents graphically some results of a brake test of the complete motor, giving the curves of speed, torque and efficiency, as referred to amperes input. It will be noted that the efficiency is a maximum, 79 per cent, at 9 amperes input, this being almost exactly the usual full-speed current consumption when the motor is driving the buckboard. What the torque, speed and efficiency will be at any other current can be obtained directly from the curves, which makes it easy, by taking readings of current, to arrive at the resistance of various

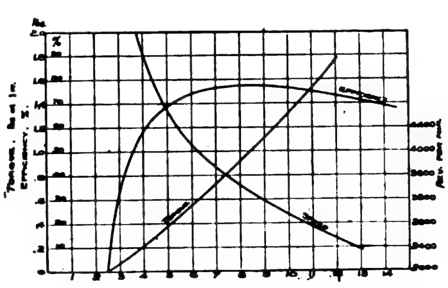


FIG. 19.—MOTOR CURVES.

kinds of road surfaces and on hills. The speed of the motor at 40 volts, the second controller notch, would, of course, be half the value shown on the curve for the same current input. With a set of curves of this kind obtained from brake test and knowing the total ratio of reduction between armature shaft and rear axle it becomes unnecessary to take any speed readings on the road, as the whole performance can be deduced from simply the voltage and current readings.

The following is a brief summary of the principal design data of the motor and the winding:

SUMMARY OF DATA FOR MOTOR.

¾ kw, 80 volts, 9-10 amperes; estimated efficiency, 75 per cent. Steel frame, 4 poles, W. E. punchings in arm; armature, 3½ inches diameter, 2¾ inches long; 18 slots 13/32 inch diameter round, ⅜ inch net diameter after insulating; No. 19 wire, d.c.c.; 46 wires per slot; 18 coils, 23 turns per coil, No. 19 d.c.c. Parallel lap winding, connections straight out to adjacent commutator segment. Field coils 94 turns per coil; No. 12 d.c.c. wire. Coils must not exceed 1 inch in depth. Weight of armature wire, 2 pounds, No. 19 d.c.c.; weight of field wire, 8 pounds, No. 12 d.c.c.

MODERN STEAM TRAPS.

BY W. T. EDWARDS.

Water of condensation which usually collects in a steam pipe system is invariably removed by drip pipes which feed into what is known as a steam trap. This is a device consisting of a reservoir wherein the water of condensation collects and is forced out into a tank, drain reservoir or sewer by the pressure of steam in the drip pipe system, the controlling valve being actuated by the water in the trap.

Steam traps should be so placed that the water gravities into them. This water may be discharged to a height or head equivalent in pressure to somewhat less than that in the pipes drained. Such traps are known as tank or separating traps.

Return traps which return the condensation to the boiler are placed in a convenient location about three feet above the water line in the boiler, the condensation being forced into the trap by the pressure in the drip pipes. When the trap discharges communication is had between it and the boiler. The entering steam from the boiler equalizes the pressure and the water gravitates into the boiler.

Steam traps are often condemned, not because of faulty design, but because they are operated under conditions for which they were never designed, and sometimes because of improper connections or arrangement of piping, valves, etc. It is the purpose of the present article, therefore, to show modern types of steam traps, their method of operation, and in some cases the manner of piping that is recommended to obtain the best results.

The A. A. Griffing Company, Jersey City, N. J., manufactures a line of return and separating traps, which is known as the "Bundy." These are made in four series, comprising 29 sizes, each series being designed to operate under certain definite

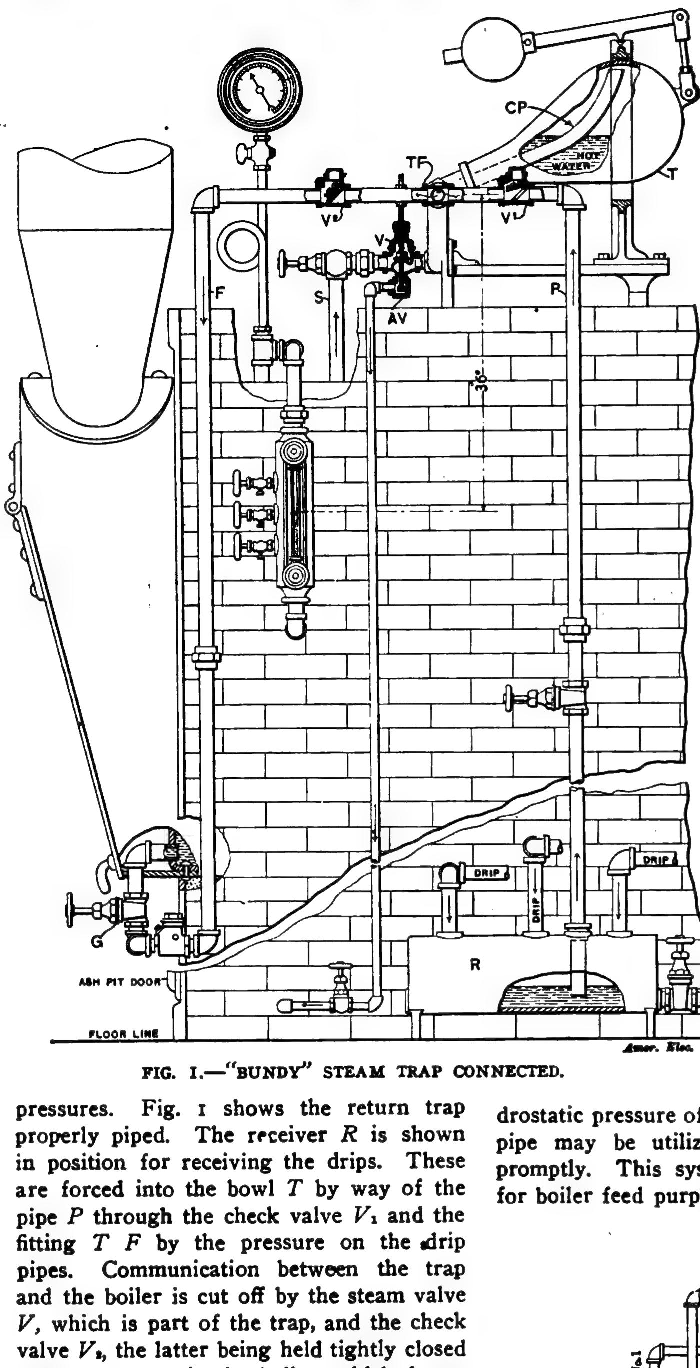


FIG. 1.—"BUNDY" STEAM TRAP CONNECTED.

pressures. Fig. 1 shows the return trap properly piped. The receiver R is shown in position for receiving the drips. These are forced into the bowl T by way of the pipe P through the check valve V_1 and the fitting T F by the pressure on the drip pipes. Communication between the trap and the boiler is cut off by the steam valve V, which is part of the trap, and the check valve V_2, the latter being held tightly closed by the pressure in the boiler, which forces a column of water through the pipe F. When the bowl T is filled with water, the combined weight overbalances the weight on the ball of the lever and causes the bowl to drop to the discharging position, which opens the valve V. Live steam from the boiler is then admitted into the trap through the pipe S, thus equalizing the pressure on both sides of the entrapped water, which then gravitates into the boiler. While the trap is discharging the check valve V_1 is held closed against the drips by the pressure of steam in the boiler and the check valve V_2 is open, permitting the water to pass through the pipe F to the boiler. When the trap is empty the bowl returns to its original position. The drip water enters and is discharged from the bowl through one trunnion, while live steam from the boiler enters through the other trunnion and the pipe C P. Should any air be trapped it is discharged through this pipe and passes through the air vent valve A V into the ash pit. This valve is fixed on the same stem as the steam valve and is open while the trap is filling and closed while it is discharging.

Should the pressure upon the steam system to be drained not be sufficient to force the drips to the bowl of the trap located above the boiler a system called the duplex is used. This comprises two return traps of the same size, one elevating the water into the other, which is placed in its proper position above the boiler. Fig. 2 shows this arrangement. The lower trap, 1, receives the water and communicates directly with trap 2, which is supplied with live steam as indicated. It has been found advisable to locate in the discharge pipe line from trap 1 a weighted check valve or spring relief valve, set to open at a pressure less than that supplied to the trap. This acts as a stop in the pipe whereby the full hydrostatic pressure of the water in the supply pipe may be utilized to fill trap No. 2 promptly. This system is sometimes used for boiler feed purposes.

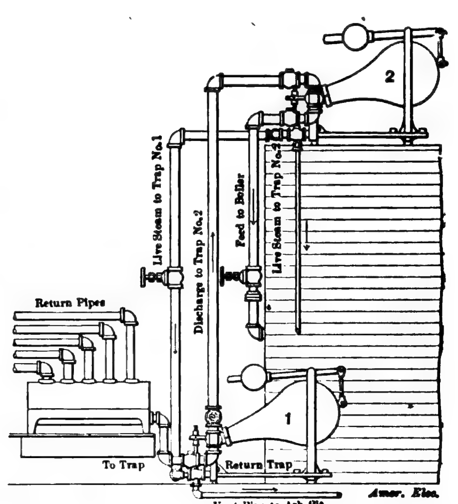


FIG. 2.—DUPLEX SYSTEM OF "BUNDY" TRAPS.

A sectional view of the 100 and 200 series of "Bundy" return trap is illustrated by Fig. 3. A cast iron receiving bowl is supported on a yoke and frame by two trunnions. The water enters the feed trunnion

D as shown in the sectional view of the yoke and passes into the bowl. The weight of this when full overbalances the weight of the ball *E* on the horizontal lever *F*.

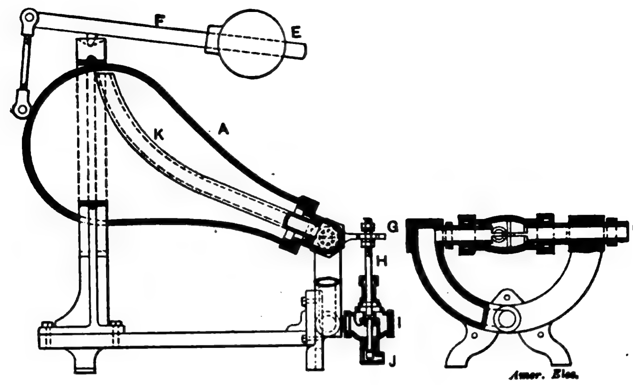


FIG. 3.—SECTIONAL VIEW OF "BUNDY" RETURN TRAP.

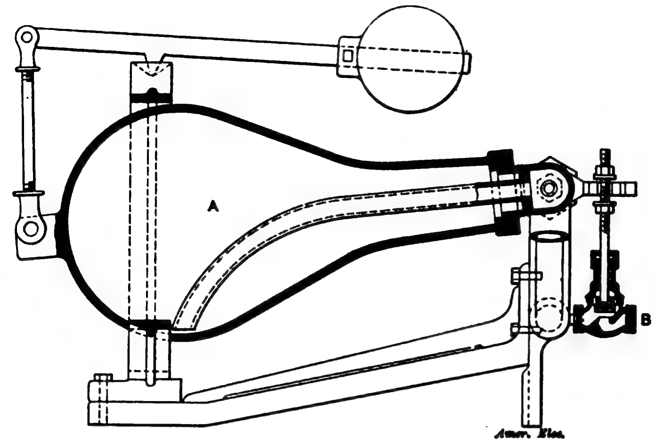


FIG. 4.—SECTIONAL VIEW OF "BUNDY" SEPARATING TRAP.

The projecting ring *G* pulls up the valve stem *H* when the bowl drops, thus opening the valve *I* and admitting live steam.

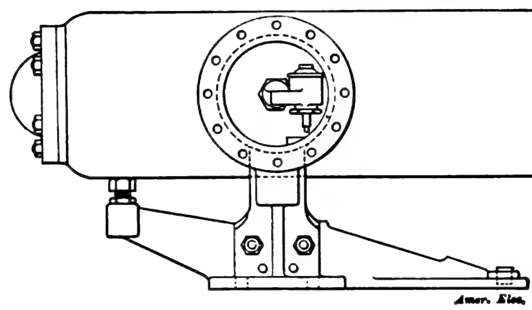


FIG. 5.—"BONER" STEAM TRAP.

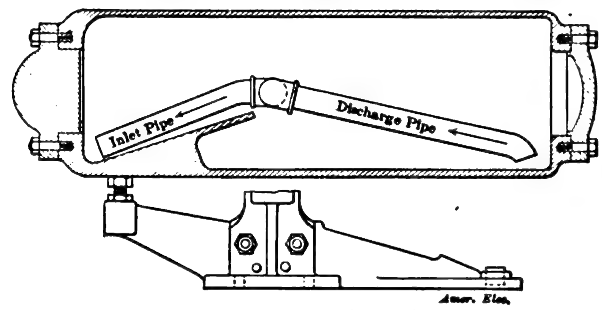


FIG. 6.—SECTIONAL VIEW OF "BONER" STEAM TRAP.

The pressure on the trap and boiler now being equal, the water is free to flow into

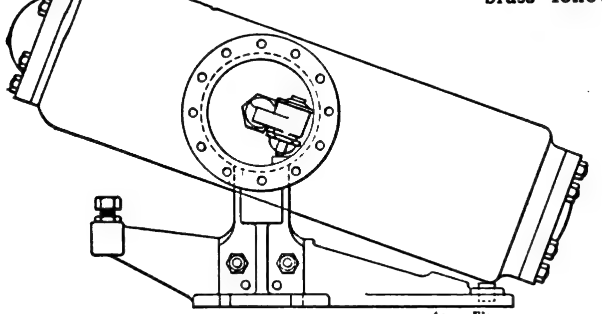


FIG. 7.—"BONER" STEAM TRAP.

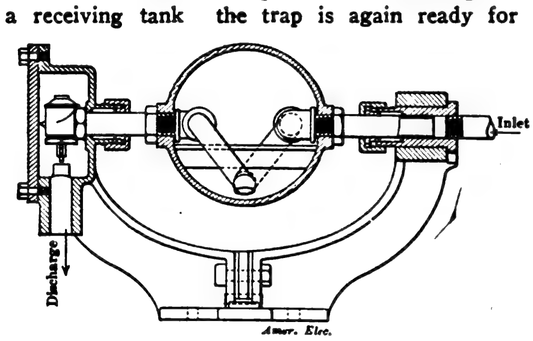


FIG. 8.—TRANSVERSE SECTION OF "BONER" STEAM TRAP.

the boiler. When the bowl is empty the weight on the lever returns it to its normal position, closing the steam valves, and at the same time opening the air valve *J* in order to permit any steam and air which may remain to escape. The steam enters the bowl through the curved pipe *K* and is discharged upon the surface of the water.

Fig. 4 shows a sectional view of a separating trap of the 50 and 75 series. This construction is practically the same as that of the 100 and 200 series; but the method of operation is somewhat different. The water enters the feed trunnion which occupies the same position as that on the return trap. When the bowl drops the discharge valve *B* is opened, as shown in this sketch. The pressure on the drips forces the water out through this valve. Before the bowl is entirely empty, and while there is enough water left to seal the end of the pipe *A*, the bowl tilts back into the filling position and effectually closes the discharge valve. This style of valve will raise water to a height equal to the pressure available, or it will discharge against any pressure which is less than the pressure on the trap, allowing a reasonable amount for friction losses. The traps are made of cast iron and the trunnion and boxes are fitted with brass followers. When a receiving tank is used to collect the drips, it is advisable to place a swing check valve in each line near the tank in order to prevent any possible short circuiting. It is also advisable to place a shut-off valve in each line near the appliance dripped.

Another trap in which the discharge valve is operated by the movement of the collecting tank is the "Boner," manufactured by James Bonar & Co., Incorporated, of Pittsburg, Pa. This trap is shown by Fig. 5. It consists mainly of a cylindrical receiving tank supported on trunnions placed nearer one end than the other. The shorter end is made heavier than the longer end in order to keep the tank in a horizontal position. When the tank is full the long end tilts, opens the discharge valve and permits the water to be forced out. The trunnions receive and discharge the drips, as shown in the sectional views. The trunnions are part of the cylinder and move with it. Fastened to the end of the outlet trunnion is the discharge valve, which is of the ball type; in the bottom of the valve is a loose pin, which comes in contact with a projection in the valve casing and lifts the ball from its seat while the tank is discharging. When the tank assumes its normal position the discharge valve closes and the trap is again ready for use. Fig. 6 shows the tank in the receiving position, Fig. 7 shows it in the discharging position

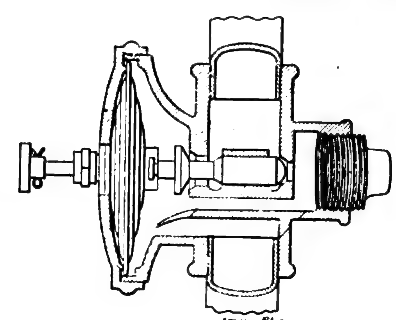


FIG. 9.—"DUNHAM" STEAM TRAP.

and Fig. 8 is a transverse section showing the inlet and discharge pipes connected with the trunnions and also the ball discharge valve. The trap is very simple and effective in operation.

Fig. 9 shows a sectional view of the "Dunham" special steam trap, manufactured

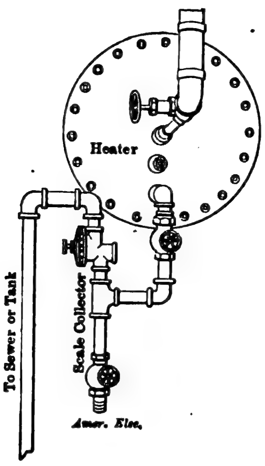


FIG. 10.—"DUNHAM" TRAP CONNECTED.

by the C. A. Dunham Company, of Marshalltown, Iowa. The principle of operation is quite different from that of the regu-

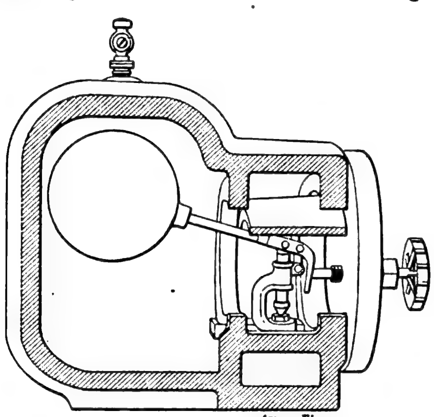


FIG. 11.—"COOKSON" STEAM TRAP.

lar type of trap. Instead of making use of floats, levers, pots or buckets to operate the valve, use is made of a chamber formed

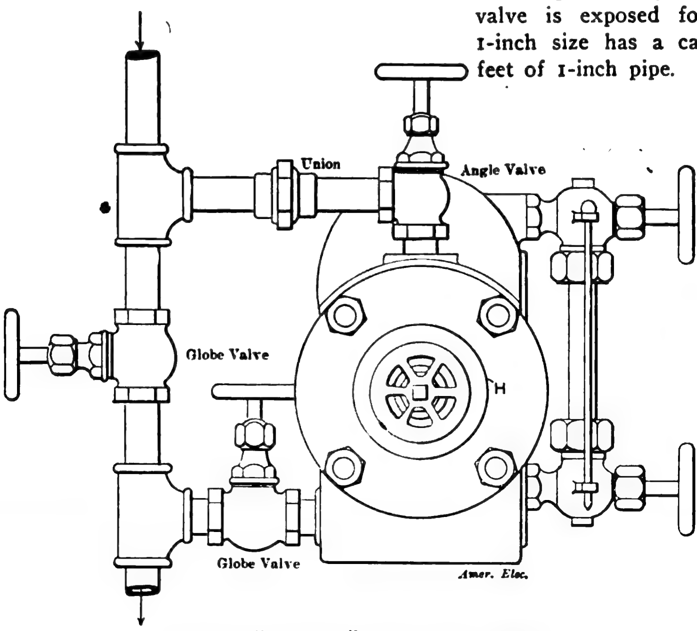
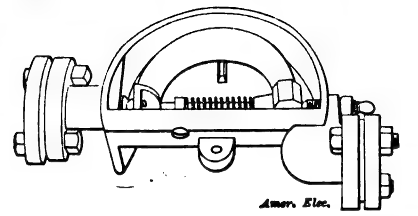


FIG. 12.—"COOKSON" TRAP CONNECTED.

by two discs of sheet bronze which contains three fluids of different degrees of volatility. These fluids flash into vapor as the temperature rises, thereby developing a pressure and closing the valve. They condense when the temperature is lowered, forming a vacuum, and the pressure upon the outside of the walls of the chamber forces them together and opens the valves From this it is evident that the valve is governed by the amount of condensation occurring in the system drained. The trap may be adjusted to discharge continuously. It is made of phosphor bronze throughout, and is peculiarly adapted to steam heating systems. As it remains open at a normal



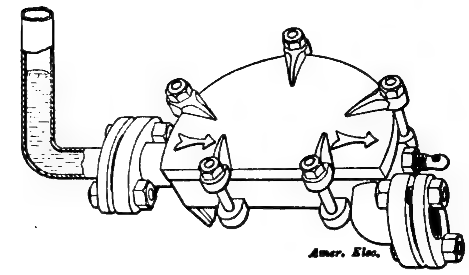


FIG. 13.—"MARCK" STEAM TRAP.—FIG. 15.

low temperature it allows air or water which may be in the heating system to escape, the trap closing when steam reaches it. It possesses an advantage in size and is designed to work from vacuum up to 125 lbs., adjusting itself to any pressure

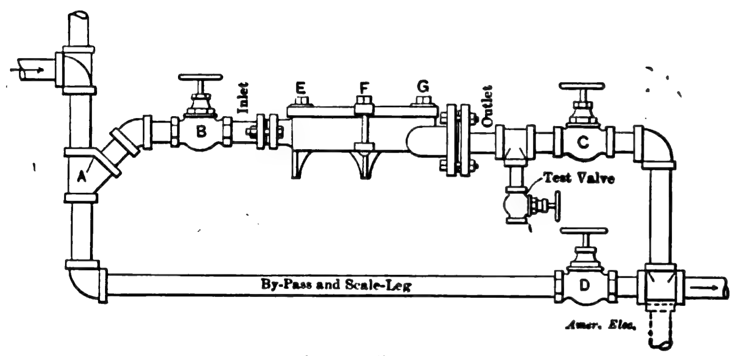


FIG. 14.—"MARCK" TRAP CONNECTED.

within these limits. The valve opening is large and the valve is double seated, as shown in Fig. 9. The trap body, disc, valve, steam cap and plug constitute all of its parts. By removing the cap the valve is exposed for any repairs. The 1-inch size has a capacity of 1000 linear feet of 1-inch pipe. There being no reservoir in this trap to catch and hold scale or foreign matter, provision must be made to prevent its entrance into the trap. This may be obtained by a system of piping like that shown by Fig. 10.

The Cookson Steam Specialty Company, of Cincinnati, Ohio, manufacture the "Cookson" steam trap. This is of neat design and large capacity and is built to withstand all ordinary working pressures. But one type of trap is manufactured and this is adapted to either high or low pressure by simply changing the valve and seat. All parts are made from templates and are interchangeable. By turning a hand wheel operating a threaded spindle acting against the valve the latter may be opened to its fullest extent, as indicated by Fig. 11, for the purpose of blowing out any foreign matter that may have lodged upon the valve seat. By backing out the spindle the valve is allowed to re-seat itself. Fig. 12 shows the trap piped and by-passed as recommended to get the best results. *H* is the hand wheel for operating the valve. Three valves are used, the arrows indicating the direction of flow of the drips.

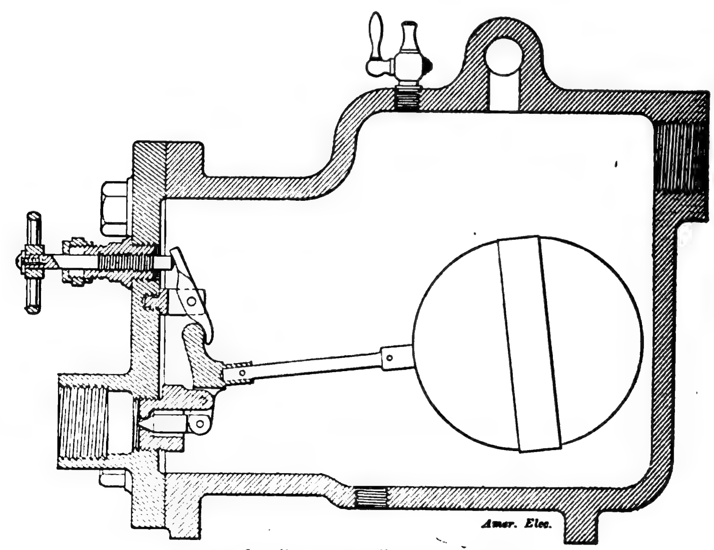


FIG. 16.—"RELIANCE" STEAM TRAP.

The "Marck" steam trap, with its cover removed, is shown by Fig. 13. This trap has but one movable part, consisting of a hollow tube bent to the shape of a crescent. This tube is made of strong selected metal,

and is filled with liquid which gasifies at 212° Fahr. When this liquid becomes gaseous, the expansive force has a tendency to straighten the tube. This causes the valve to press against the valve seat and close

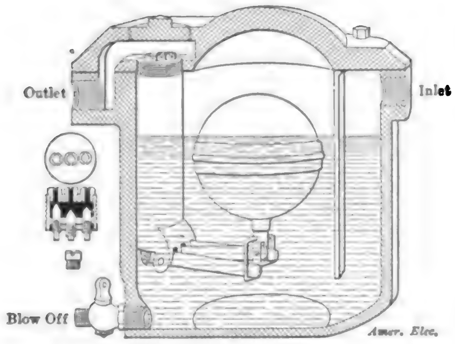


FIG. 17.—WRIGHT "EMERGENCY" STEAM TRAP.

the trap. When the temperature falls below 212° Fahr. liquefaction takes place and the tube assumes its normal position, drawing the valve away from its seat and opening the trap. The trap is automatic, depending for its effective working on the tube in which the fluid is contained. It is simply an automatic valve or separating trap, whch always opens below 212° Fahr. and closes above that temperature. It will operate at any pressure below 200 lbs. to the square inch, and since it is not provided with a receptacle for the collection of sediment, scale, etc., it is advisable to construct a trap or scale leg by extending the inlet pipe as indicated by Fig. 14. This illustration also shows the trap by-passed. Fig. 15 shows another view of the "Marck" trap, which is manufactured by E. F. Houghton & Company, Philadelphia, Pa.

Another separating trap, the valve of which is operated by a float, is shown in section by Fig. 16. This is called the "Reliance" trap, and is manufactured by the Reliance Gauge Column Company of Cleveland, Ohio. The working of the trap is so clearly indicated in the engraving that no description is necessary. The traps are made in six sizes, from ½-in. to 2-in. connection inclusive, the smallest draining 1000 ft. and the

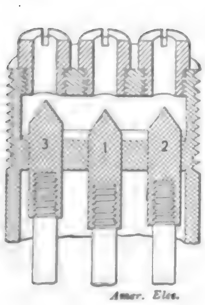


FIG. 18.—WRIGHT VALVES AND SEATS.

FIG. 20.—"GOLDEN" HIGH-PRESSURE TILTING STEAM TRAP.

largest 16,000 ft. of one-inch pipe. When the pressure under which the trap is to work is less than 30 lbs., a large valve outlet is provided.

The traps already described are provided with single valves, but the one shown in Fig. 17 is provided with three. This illustration shows a sectional view of the Wright "Emergency" trap, manufactured by the Wright Mfg. Company of Detroit, Mich. This trap operates successfully on all pressures from 20 to 200 lbs. per square inch. A low pressure trap called the "Victor" is made by the same company for pressures up to 20 lbs.

The "Emergency" trap consists of a cast iron chamber wherein the water collects. Within this chamber is a specially designed and reinforced copper ball float, which actuates the three valves. The valves are arranged so that a normal quantity of water is discharged through one valve. Should the quantity of water be abnormal the float is raised high enough to open the second

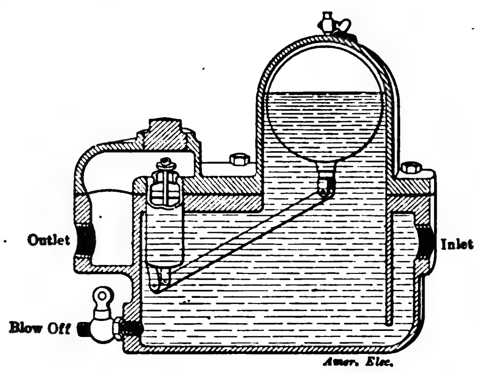


FIG. 19.—"VICTOR" STEAM TRAP.

valve, and in cases of emergency the third valve is also opened, the float then being in its highest position. When the three valves are open they provide for the full capacity of the inlet pipe. Ordinarily one valve is sufficient to do the work. The valves and seats are made of steel jet metal and are so arranged as to be easily renewed or repaired without removing the cover, a plug being provided for that purpose. The valves are held in alignment by a bar placed diametrically across the tube, which also serves to center the valves into the seats. An enlarged view of this arrangement is shown by Fig. 18.

The "Victor" low pressure trap is similar in construction and operation to the "Emergency" trap with the exception that it has but one valve. This, however, is large enough to enable the trap to handle large quantities of condensation. Both types of trap are provided with gauge glasses and blow-off cocks and the "Victor" is provided in addition with an automatic air valve. This trap is shown in section by Fig. 19.

Fig. 20 shows the Golden high-pressure, automatic tilting steam trap made by the Golden-Anderson Valve Specialty Company of Pittsburg, Pa. The trap is shown in normal position ready to receive the condensation. When sufficient water is trapped to overcome the weight of the ball on the lever, the trap drops, thereby opening the steam valve and the water is forced out. The trap then resumes its normal position under the action of the weighted lever. The trap is well made, all working parts being of bronze and removable.

The American Electric & Controller Company of New York City is the manufacturer of the "Thoen" steam trap, shown in section by Fig. 21. The operating element of the trap consists of a bucket supported at its upper end between the forked ends of a counterweighted lever. The counterweight exactly balances the weight of the bucket when it is empty. That is to say, the moments of all the weights on the right side of the pivot are equal to those on the left

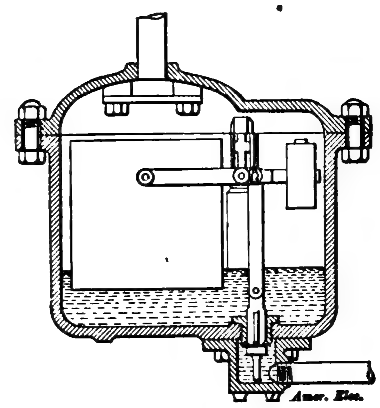


FIG. 21.—"THOEN" STEAM TRAP.

side, so that when the trap is empty the moving parts are in equilibrium. When the trap begins to fill the preponderance of weight on this side of the lever support keeps the outlet valve tightly closed. When the bucket is full and overflows, the body of the trap begins to fill up and the buoyancy of the bucket increases until such a point is reached that the moments on each side of the fulcrum are again nearly equal, when the unbalanced steam pressure on the upper side of the valve seat causes it to open. Discharge then, of course, takes place until the level of the water outside the bucket lowers to such a point that the weight of the water in the bucket again causes the outlet valve to close. Since the bucket is full of water at all times when the trap is in operation, and from the nature of its operation, the discharge of liquid is seen to be but a small amount at a time, and the action of the trap very sensitive. The outlet valve is also submerged at all times, and this, of course, prevents the escape of steam. A feature which is not perhaps noticeable is that the outlet hood

or chamber is attached to the main body by four bolts placed exactly 90 degrees apart, so that the outlet pipe may be turned in any one of these four positions.

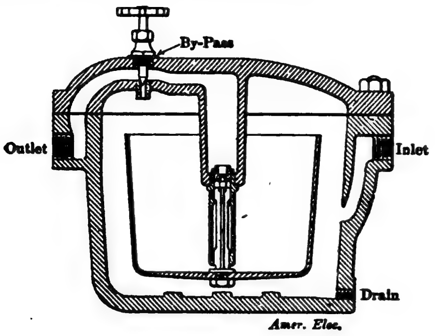


FIG. 22.—"CRANE" STEAM TRAP.

The Crane Company of Chicago manufactures a steam separating trap of the bucket type, as shown by Fig. 22. In operation the trap does not differ from the many

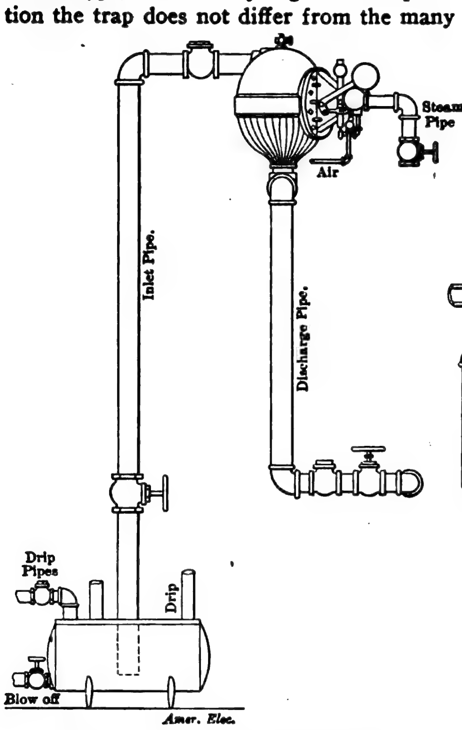


FIG. 23.—"CURTIS" TRAP CONNECTED.

similar traps of this type, the condensation entering at the inlet side and surrounding the float or bucket and lifting the valve to

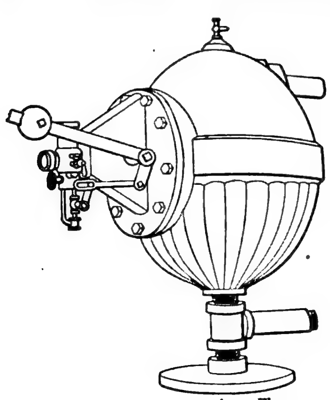


FIG. 24.—"CURTIS" STEAM TRAP.

its seat. The rising water fills the bucket and causes it to sink, thus opening the valve, which permits the water to be forced out of the trap by the pressure of the steam in the drip system. After sufficient water has been discharged out of the bucket to lighten it the water on the outside raises it, and again forces the valve against its seat and the trap is again ready for the next discharge. The float is of pressed steel and rarely gives cause for trouble. The

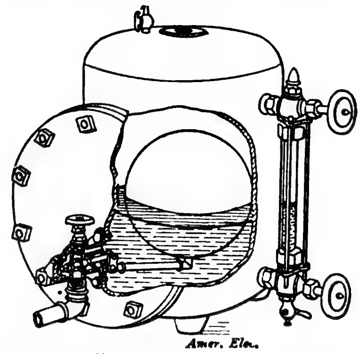


FIG. 25.—"CURTIS" BALANCED TRAP.

body of the trap is large and forms a convenient place for sediment to lodge to be blown out through the drain, the slow rising of the water to the top of the bucket being favorable for this. The valve and seat are located in the top section of the trap, and are thus protected from sediment which lodges in the bottom of the

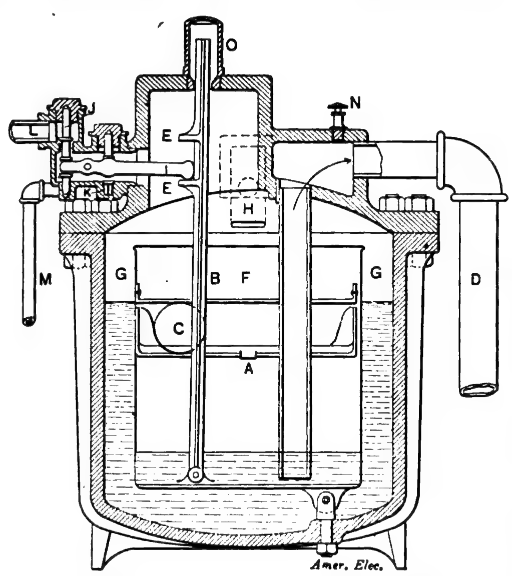


FIG. 27.—ALBANY "CLASS A" STEAM TRAP.

trap. The traps are equipped with a bypass and, if desired, a gauge glass is provided.

The Julian d'Este Co. of Boston, Mass., manufactures a line of "Curtis" traps that includes both the return and the non-return types. The return trap operates practically the same as those already described, being located above the boiler and having the water of condensation forced into it from a receiver by the pressure of the steam in the drip system.

The water rising in the trap raises a float which in turn operates a valve letting full boiler pressure on to the surface of the water in the trap. A check valve prevents the water from returning to the receiver and it flows by gravity into the boiler. The series of movements follows so closely those already described in detail that it is needless to enter upon a further description. Fig. 23 shows a trap applied to a boiler, and Fig. 24 shows an enlarged view of the same trap. Fig. 25 shows the "Curtis" balanced trap, which consists of a cylindrical pot with rounded ends. The operation of the valve is by means of a ball float made of copper. On one side of the body of the trap is a nozzle of sufficient diameter to admit the float. This nozzle is covered with a strong plate to which is bolted the composition valve. The valve consists of two discs of equal area on a single stem, one with a short sliding fit, the other with a ground seat taper fit, which guides it on to its seat, while the valve stem is guided by a spider with three arms, and is loosely connected by a knuckle joint to the float. The valve stem is in two parts, the outer one carrying the discs screwing into the inner one.

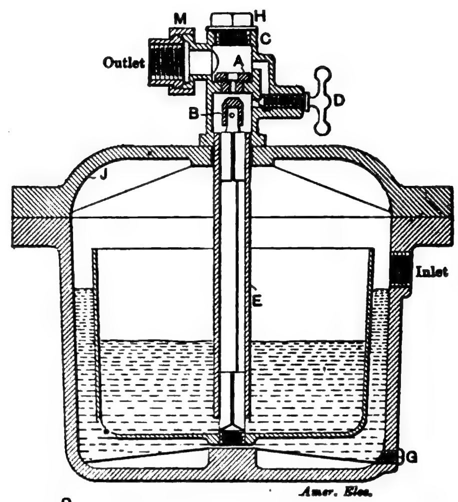


FIG. 28.—ALBANY NON-RETURN STEAM TRAP.

A bucket return trap is manufactured by the Albany Steam Trap Company of Albany, N. Y. It consists of an approximately cylindrical body provided with a closed bottom. A removable bonnet forms the closure for the top of the casing and is secured thereto by through bolts. An open top copper bucket is attached to the casing by a hinged joint in such a manner as to allow it to freely tilt as occasion requires. Channeled guides are arranged within the bucket, and in these guides are rolling counterweights, which complete the tilting movement of the bucket by gravitating to the depressed ends of the guides. A valve-operating rod is connected by a joint to the bottom of the bucket; the upper end of the rod is fitted to move more freely in a chambered guide secured to the bonnet. The rod is provided with tappets projecting laterally, which are adapted to engage against the inner end of the equalizing valve lever. The tappets are spaced such a distance apart as to allow this lever to work freely between them. The purpose of this equalizing valve is to admit live steam direct from the boiler when it is required. The valve is shown connected to the bonnet, the casing which contains the equalizing valve also containing a small exhaust valve.

Water of condensation enters through the inlet check-valve and opening *H* into the space *G* between the bucket and the outer case. The bucket *F* is forced upward by this water, and it is this action of the bucket that operates the equalizing valve *J* and the exhaust valve *K* through the medium of the valve rod *B*. When the bucket is raised sufficiently, the counterweights *C* roll on the channeled guides *A* to the side of the bucket that is adjacent to the hinge joint, thereby providing a sudden impulse to the

tilting of the bucket and making the operation of the equalizing valve more positive.

When the space *G* is filled the water flows into the bucket, which when filled tilts downward, causing the ball weights to roll to the opposite side, giving a sudden impulse downward and bringing the upper tappet *E* on the rod *B* suddenly against the inner end of the valve lever *I*, thus opening the inlet equalizing valve *J* for the admission of steam at boiler pressure. The pressure in the trap and in the boiler now being equal, the water flows by gravity from the trap into the boiler through the syphon pipe *D*, passing through a check valve on the way. When the bucket is emptied of water, it again moves upward, going through the operation just described of closing the equalizing valve *J* and opening the exhaust valve *K* to the exhaust opening *M*. The purpose of this exhaust valve and opening is to allow the escape of any steam that might remain.

The small air valve shown on top of the discharge chamber is to relieve the discharge pipe of air when first placing the trap in operation. An automatic air valve is provided, which is adjusted to relieve any accumulation of air from the trap cylinder during its regular operation. This trap is shown in section by Fig. 27.

A duplex system is also provided for cases where the pressure in the drip system is not high enough to force the water into the return trap; it consists of two return traps, one placed so as to receive the water from the drip system by gravity and discharging it into another trap placed above the boiler which operates simply as a return trap.

The Albany Steam Trap Company also makes two classes of non-return traps, one for pressures up to 100 lbs. and the other for pressures from 100 to 175 lbs. These are called class "C" and class "B." Class "C" trap is shown in Fig. 28, and needs but little explanation. Class "B" is called the high pressure trap and has several features, one of which consists in protecting the discharge valve by a thin disc having in it the proper sized opening to allow the water to flow without undue friction; this disc is placed in the body of the discharge valve outside of the valve seat, and instead of the rapid wearing away of the valve and its seat, the disc, which may be readily replaced, is worn, entailing a minimum expense.

Referring to Fig. 29, it will be seen that the water enters the trap through the inlet pipe *A*, in which there is provided a strainer *B* for preventing dirt and sediment from entering the trap proper. After leaving the strainer the water enters the small chamber *D*, formed in the top casting, running thence through an opening into the space between the casing and the bucket. The rising water carries the bucket with it, thus operating the discharge valve through the guide sleeve and the bell-crank *N*. The valve seat is marked *K*, the valve *H*, and the valve stem *G*. When the bucket has received enough water to seal the lower end of the pipe, *P*, see Fig. 29, the pressure of steam on the trap will force part of the water from the outside of the bucket, as well as some from the bucket, up into the tank *T* through the pipe *P* and the pipe *C*. When the tank *T* is full, the water fills the bucket, which drops and operates the discharge valve. Water is forced out of the bucket through the discharge pipe *E* into the chamber *F* and through the valve *K*, passing through the disc *L*, mentioned above. When enough water has been discharged to uncover the lower end of the pipe *P* steam enters the tank *T*, equalizing the pressure and allowing the water in the tank to flow into the space between the bucket and the outer shell, thus raising the bucket to its highest position and closing the discharge valve. The trap is provided with an air valve.

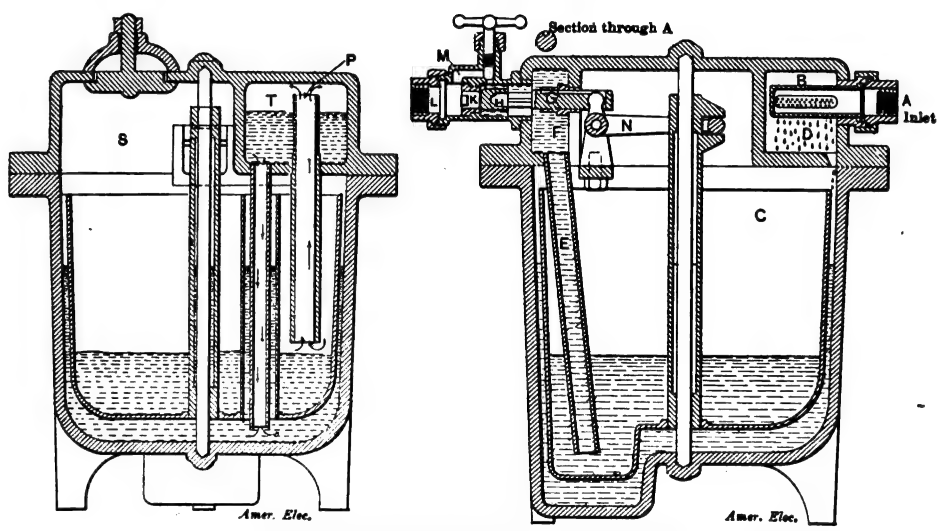


FIG. 29.—ALBANY "CLASS B" STEAM TRAP.

CARELESS HANDLING OF DIRECT-CURRENT MOTORS.

BY W. G. VIALL.

The writer's attention was recently attracted to the instruction card shown in Fig. 1. This card was got out by a central station company for the purpose of instructing anyone whose duty it might be to start and stop any of the motors owned by the company and rented to its customers. Most of the motors were of the Edison bi-polar type and were operated on 500-volt current; wattmeters were used on nearly all of the motors. Fig. 2 is a diagram of the wiring showing the wattmeter connected between the main switch and motor. The single-pole switch referred to in the instructions is mounted on the terminal board of the motor and is used for opening the armature circuit only. The principal feature of this case is the instruction card; by following the directions given more harm would be liable to result than if no directions were given at all. The instructions for starting the motor are all right, as the field is allowed to build

EDISON RESISTANCE BOX.

TO START MOTOR.

FIRST.—See that Resistance is all in.
SECOND.—Close Double Pole Switch.
THIRD.—Close Single Pole Armature Switch.
FOURTH.—Turn out Resistance Slowly.

CAUTION.

Never put a load on the Motor until the resistance is All out.

To STOP MOTOR.

FIRST.—Open Single Pole Armature switch.
SECOND.—Open Double Pole Switch.
THIRD.—After Motor has stopped, turn in Resistance

CAUTION.

Never allow Motor to stand with Brushes off of the Armature.

Cost of repairs caused by not following above directions will be charged to the user.

FIG. 1.—INSTRUCTION CARD.

up to a considerable extent before current is applied to the armature by closing the single-pole switch. It is in the instructions for stopping the motor where the fault lies. Opening the single-pole switch first will cut out the armature and leave the field alive; then when the main or double-pole switch is opened the field circuit will be broken

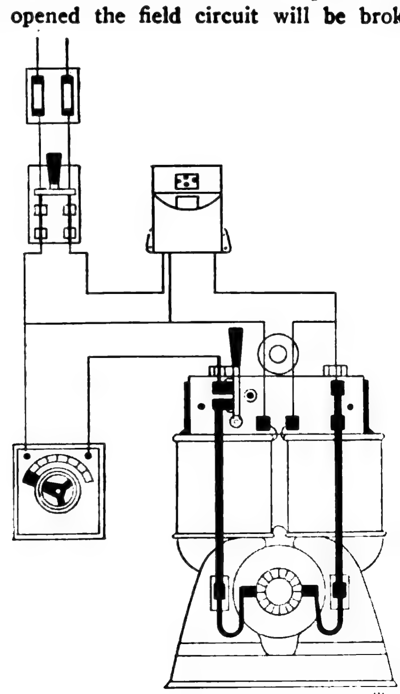


FIG. 2.—DIAGRAM OF CONNECTIONS.

quickly and the reactive kick of the field coils will cause a sudden rush of current through the meter, under a voltage many times greater than the normal running voltage. The result will be a burned-out, short-

circuited or open-circuited pressure coil in the meter, and should there happen to be no meter in the circuit to take up the discharge, the voltage might rise to an instantaneous value sufficiently high to break down the field insulation and ruin the field coils. The first thing to be done in stopping the motor, of course, is to open the main switch, and after the motor stops the single-pole switch should be opened and the starting resistance cut in. By stopping in this way the field and armature would be connected with each other until the motor stops running, and from the instant the main switch is opened the motor will act as a dynamo and supply current to the field from the armature; as the armature gradually comes to a stop the field current gradually diminishes so that when the single-pole switch is opened no current will be flowing in the field circuit.

DISEASES OF ELECTRICAL MACHINERY.

BY F. B. CROCKER AND S. S. WHEELER.

J. Dynamo Fails to Generate.

This trouble is a particular case of the preceding class, "Voltage of Generator Too High or Too Low." It is usually due to the inability of a self-exciting generator to "build up" its field magnetism. The proper starting of such a dynamo requires a certain amount of residual magnetism, which must be increased to full strength by the current generated in the machine itself. This trouble is not likely to occur in a separately excited machine, and if it does it is usually due to the fact that the excited fails to generate, and therefore amounts to the same thing.

Cause 1.—Residual magnetism too weak or destroyed, due to (*a*) vibration or jar, (*b*) proximity of another machine, (*c*) earth's magnetism, (*d*) a strong current through the armature when there is little or no field current tending to neutralize or reverse the field magnetism, owing to the back ampere-turns, (*e*) accidental reversed current through shunt or series field coils, not enough to completely reverse magnetism. The complete reversal of the residual magnetism in any dynamo will not prevent its generating, but will only make it build up a current of opposite polarity. Sometimes reversal of residual magnetism may be very objectionable, as in case of charging storage batteries; but, although the popular supposition is to the contrary, it will not cause the machine to fail to generate. Cases (*d*) and (*e*) are likely to occur with self-exciting direct-current generators working in parallel, or with a storage battery, but not to a single machine.

Symptom.—Little or no magnetic attraction when the pole pieces are tested with a piece of iron.

Remedy.—Send a magnetizing current from another machine or battery through field coils, then start and try the generator again; if this fails, apply the current in the opposite direction since the magnets may have enough polarity to prevent them from building up in the direction first tried.

Shift the brushes backward to make the armature magnetism assist that of the field. Turn machine around or change its polarity, so that the magnetism which the earth or the adjacent machine tends to induce is in the same direction as the residual magnetism. Dynamos should be placed with their opposite poles toward each other, and the north pole of a machine should preferably be placed toward the north (which is magnetically the *south* pole of the earth), but the earth's magnetism is hardly strong enough to reverse or even materially affect the residual magnetism.

Cause 2.—Reversed connections or reversed direction of rotation.

Symptom.—When running, pole pieces show no attraction for a piece of iron. The application of current from another source will not, in this case, make a dynamo generate, as in Cause 1, because whichever way the field is thus magnetized the resulting current then generated by the armature opposes and destroys the magnetism.

Remedy.—(*a*) Reverse either the armature connections or the field connections, *but not both.* (*b*) Move brushes through 180 degs. for two-pole, 90 degs. for four-pole machines, etc. (*c*) Reverse direction of rotation. After each of the above changes the field may have to be built up by applying current as in Remedy I, because the conditions in these cases tend to destroy whatever residual magnetism may have been present.

Cause 3.—Short-circuit in the machine or external circuit.

Symptom.—Magnetism weak, but usually perceptible.

Remedy.—If the short-circuit is in the external circuit, it will prevent the building up of a shunt dynamo until external circuit is opened. But with a series dynamo it will hasten the "building up." If the short-circuit is within the machine, it is likely to prevent the building up of either shunt or series machines and it should be found by careful inspection or testing. In these cases do not connect the external circuit until the short-circuit is found and eliminated. A comparatively slight short-circuit, such as that caused by a defective lamp socket or copper dust on the brush-holder or commutator, may prevent a shunt generator from building up. (See "Sparking," Causes 5 and 8.) Too many lamps or other load might also prevent a shunt dynamo from building up its field-magnetism, in which case the load should be disconnected in starting.

Cause 4.—Field coils opposed to each other.

Symptom.—Apply current to the field coils, as in Remedy I, and the following symptom will exist: If the pole pieces of a bipolar machine are approached with a compass or other freely suspended magnet, they both attract the same end of the magnet, showing them both to be of the same, whereas they should always be of opposite, polarity.

For similar reasons the pole pieces are magnetic when tested separately with a piece of iron, but show less attraction when the same piece of iron is applied to both pole pieces at once, in which latter case the attraction should be much stronger. In multipolar machines these tests should be applied to consecutive pole pieces.

Remedy.—Reverse the connections of one of the coils in order to make the polarity of the pole pieces opposite. The pole pieces of multipolar machines should be alternately north and south (when tested by compass).

Cause 5.—Open circuit.

This may be due to: (*a*) Broken wire or faulty connection in machine, (*b*) brushes not in contact with commutator, (*c*) safety-fuse blown or removed or circuit breaker open, (*d*) switch open, (*e*) external circuit open.

Symptom.—If the trouble is due merely to the switch or external circuit being open, the magnetism of a shunt-wound generator may be at full strength, and the machine itself may be working perfectly; but if the trouble is in the machine, the field-magnetism will probably be very weak.

A break in the field circuit of a separately excited generator will prevent it from generating, and is indicated by the fact that the exciter has its field magnetism, while the main generator has not. One break in the armature of a direct-current machine does not prevent it from generating but produces sparking (Cause 6). A break in a single-phase armature prevents it from generating; a two-phase or a three-phase Y armature generates single-phase, but a Δ armature continues to give three-phase currents with diminished capacity in amperes.

Remedy.—Make very careful examination for open circuit; if not found, test separately the field coils, armature, etc., for continuity with magneto or cell of battery and electric bell. (See "Motor Stops," Cause 3.)

A break, poor contact, or excessive resistance in the shunt field circuit or regulator of a generator will also make the magnetism weak and prevent its building up. This may be detected and overcome by cutting out the rheostat for a moment, the surest way being to connect the two terminals of the field coils to the positive and negative brushes, respectively.

A break or abnormally high resistance anywhere in the circuit of a series-wound dynamo will prevent it from generating, because the field coil is in the main circuit. This may be detected and overcome by short-circuiting the machine for a moment in order to start up the magnetism.

Either of these two remedies by short-circuiting should be applied carefully, and not until the pole pieces have been tested with a piece of iron to make sure that the magnetism is weak.

Cause 6.—Brushes not in proper position.

Symptom.—The magnetism and voltage are increased by shifting the brushes.

Remedy.—It often happens that the brushes are not set at the proper point; in fact, they may be set exactly wrong, so that the dynamo is incapable of generating any current whatever. This trouble is usually due to the fact that the proper position for the brushes is not the same for all kinds of machines. Almost all ring armatures and many drum armatures require the brushes to be set opposite the *spaces* between the pole pieces. On the other hand some armatures are wound so that the brushes have to

be set in line with the centers of the pole pieces, or in some intermediate position. Most multipolar machines have as many sets of brushes as there are pole pieces, while some have cross-connected armatures or have a series or two-circuit armature winding (for example, railway motors) so that only two sets of brushes are required. Four-pole machines with only two sets of brushes require them to be set at 90°; six-pole machines, either 60° or 180°, and so on.

The fact is, that the proper position of the brushes depends upon the particular winding, internal connections, etc., and ***no one should ever assume to know where to set the brushes unless*** he is familiar with the particular type of machine. A blue print or

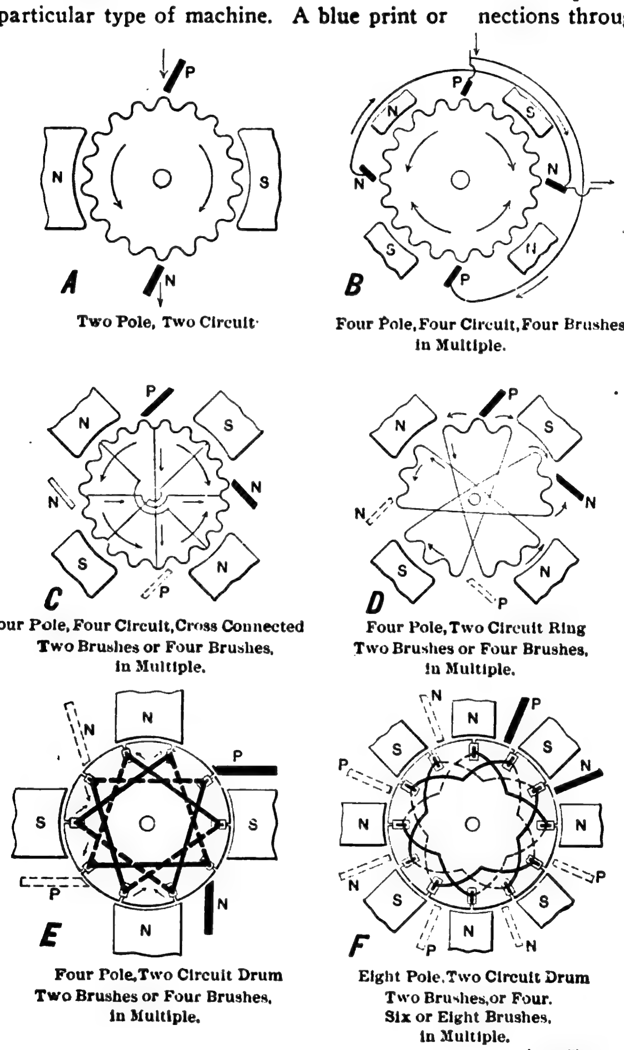


FIG. 1.—PRINCIPLES OF THE CONNECTIONS IN THE DIFFERENT TYPES OF ARMATURES.

other definite instructions should always be obtained and followed, and if these are not available the matter may be determined by careful trial. The proper position of brushes is the same for generators and motors, except that in the former the brushes are given a *lead,* that is, shifted a little in the direction of rotation, whereas motor brushes should be set a little backward. This shifting is necessitated by armature reaction, which distorts the field-magnetism.

The positions and number of brushes for each kind of armature are shown in Fig. 1, which shows also the *arrangements of circuits* in each of the leading types.

A is the armature for the ordinary two-pole machine, and may be drum or ring wound. The current enters (in a generator) through the negative brush, passes around both sides of the armature, and out through the positive brush. Hence this is called a two-circuit armature.

B is a four-pole ring armature, but being similar in principle may also represent a four-circuit drum winding in a four-pole machine. As there are two more poles, it is necessary to use two more brushes to collect the currents. This gives two brushes through which current enters and two through which it leaves; consequently, each pair of brushes must be joined in multiple to carry all the current to the mains.

C is a four-pole armature in which the additional currents are carried across to the first pair of brushes by means of connections through the center of the armature. Therefore, the entire current may be taken off by these brushes, or two more may be added to reduce the heating effect, in which case they must also be connected in multiple to the first pair, as in case *B*.

With either *B* or *C*, since there are two parts of the armature winding, under the influence of different poles, but in parallel with the mains, it is evident that if the electro-motive force in one part of the winding is weaker than in the other, through inequality of the poles or otherwise, it will short-circuit the other part of the winding and give trouble. (See "Sparking," Cause 9.) This does not occur in A, because both parts of the winding are influenced by the two poles of a single magnet. *D* is a four-pole armature in which the windings do not connect together in parallel but in *series,* thus overcoming the above objection. It is a ring winding, and each coil is connected to the one diametrically opposite. An examination will show that though the poles alternate, the wire is all arranged so that the current flows in a single pair of circuits, as in *A*. This also permits of the use of larger wire and fewer turns, as they are connected in series instead of in multiple circuit.

E is a series or two-circuit drum winding corresponding to the ring winding *D*.

To facilitate tracing the course of the current, the arrangement is represented with the smallest possible number of bars. Many more are used in practice.

F is a series or two-circuit drum armature for eight poles. The principle is the same, but the limit of brush adjustment is smaller. The entire range from zero to full e.m.f. is covered by moving the brush one-eighth of the circumference. As the winding is all in series, two brushes only are necessary, but as many more as desired may be added between the other poles, and then connected in multiple to the first ones.

Letters on Practical Subjects

Communications intended for publication in this department must be received at this office not later than the 15th of the month prior to the date of publication.

Mr. Malcolm's Problem in Lamp Connections.

I offer the diagram herewith enclosed (Fig. 1) as a solution of Mr. Malcolm's problem published last month. The switches, *A* and *B*, are evidently double-break knife switches, and in order to avoid any permanent connection between the two branch circuits and also allow the switches both to control the single lamp, the latter is connected to the hinges of the switches.

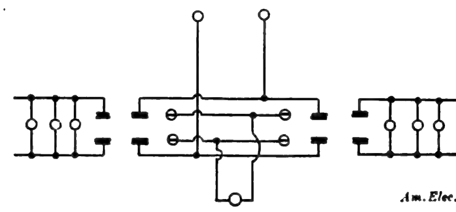


FIG. 1.—MR. BONE'S SOLUTION.

Closing either switch, therefore, will connect the lamp to the supply circuit along with the regular branch controlled by that switch.

Reading, Mich. FRANK W. BONE.

[The same solution was supplied by Messrs. R. E. Gibbs, Springfield, Wis.; Geo. H. Lackey, Long Branch, N. J.; Wilson A. McCown, Ladonia, Tex.; C. H. Pool, New York, and Fred R. Price, Columbus, Ohio.—EDITOR.]

The enclosed diagram (Fig. 2) shows one method of meeting the requirements of Mr. Malcolm's problem. The single or pilot

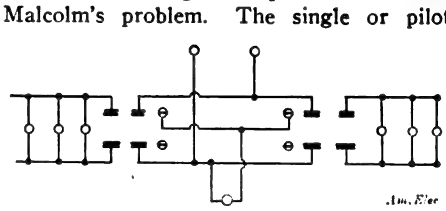


FIG. 2.—MR. CARTER'S SOLUTION.

lamp is connected permanently on one side to the supply circuit, which is permissible with less than 12 lamps, and the other terminal is connected to the hinge posts of the two switches which correspond, when closed, to the other side of the supply circuit. Thus the two branch cricuits are en-

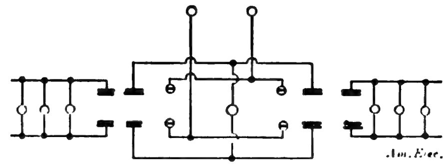


FIG. 3.—MR. BULLARD'S SOLUTION.

tirely independent, as required, and the lamp is lighted when either of the switches is closed.

Baltimore, Md. EDW. G. CARTER.

I submit herewith a diagram of connections (Fig. 3) as a solution of Mr. Mal-

colm's problem published in this department last month. The switches are double-break, with the hinges connected to the supply circuit and the inner jaws to the

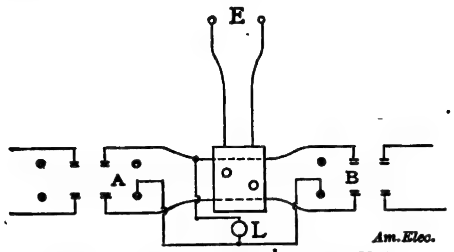
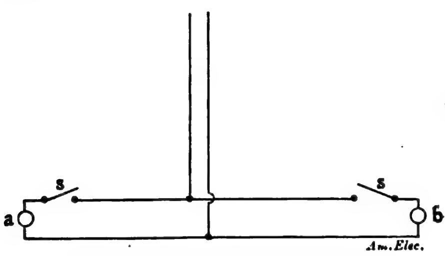


FIG. 4.—MR. MALCOLM'S SOLUTION.

single lamp, so that when either of them is closed it connects its branch circuit and the single lamp simultaneously to the supply circuit, *E*.

Warren, R. I. J. E. Bullard.

[The same solution was furnished by Messrs. Herbert A. Fiske, Kingston, R. I., and Chas. H. Morrison, San Francisco, Cal. The solution of Mr. Malcolm is shown by Fig. 4, which, it will be noted, is practically identical with that offered by Mr. Carter



FAULTY ELECTROLIER CIRCUIT.

(Fig. 2), the only difference being the omission of the branch block, which might or might not be allowable, according to the sizes of wire used.—Editor.]

A Faulty Electrolier Circuit.

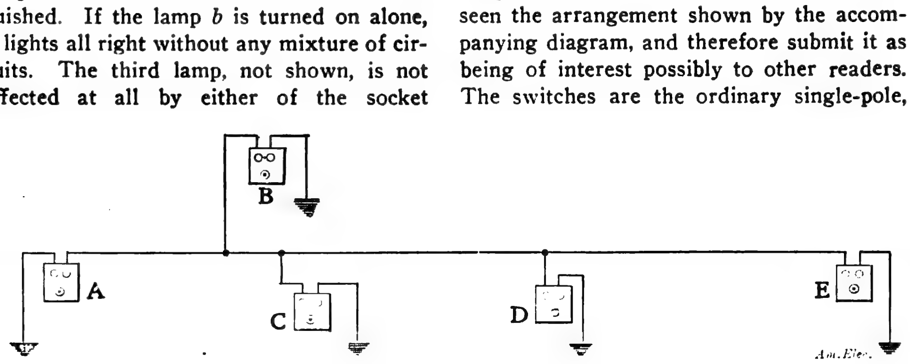
A three-light electrolier carrying 110-volt lamps is connected up in the usual way, the lamps being in key sockets. In the accompanying diagram two of the lamps are indicated by the letters *a* and *b*, and the socket switches by *s* and *s*. When all three lamps are turned off (only two are shown in the diagram), turning on the lamp *b* at the socket lights that lamp and also lights the lamp *b*; when *a* is turned off *b* is also extinguished. If the lamp *b* is turned on alone, it lights all right without any mixture of circuits. The third lamp, not shown, is not affected at all by either of the socket switches of the other two lamps. I should like readers of this journal to suggest what the trouble is; it is very probably a cross or ground of some sort, but it has not been located yet.

Portland, Ore. Leonard F. Fuller.

Problem in Telephone Circuits.

Five telephones are installed on a party line, as indicated by the accompanying diagram. The instrument at *A* is an 80-ohm series set, which was put in by mistake; all of the others are bridging sets of 1600 ohms each. It is impossible to call up station *A* from station *C* direct, but it can be called up from *B, D* or *E* in the usual way. Station *A*, however, can call up any of the others, including *C*, and station *C* can call up any of the others except *A*. I have submitted this to several practical telephone men, but none of them has explained it; perhaps some of the American Electrician readers can work it out.

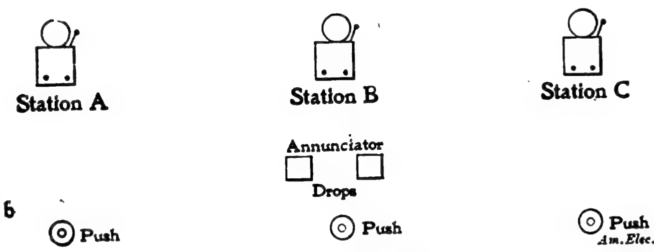
Hackley, Wis. J. R. Brazell.



PROBLEM IN TELEPHONE CIRCUITS.

Another Bell Wiring Problem.

I would like to offer the following problem in bell wiring, for the consideration of your readers: Three stations, *A, B* and *C*, are equipped each with a single-stroke bell



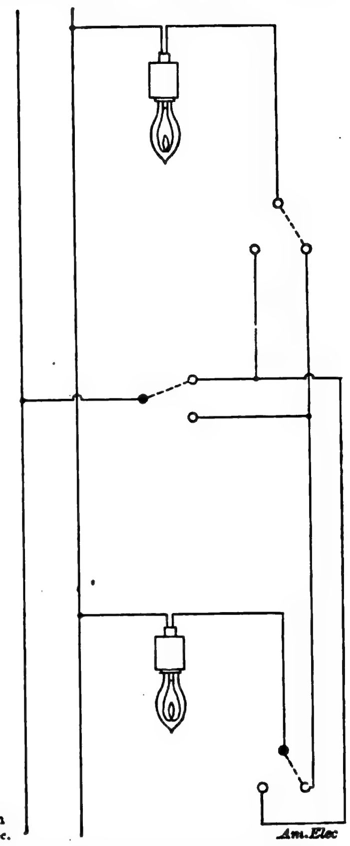
PROBLEM IN BELL WIRING.

and push-button. Station *B* is also provided with two annunciator drops, a second push-button and a battery.* It is required that the push-button at *A* must ring all the bells and throw one of the annunciator drops; one button at *B* must ring the bells at *A* and *B*; the other button at this station must ring the bells at *B* and C; the button at station *C* must ring all the bells and throw the second annunciator drop at station *B*.

Wilmington, Del. William Merrill.

Novel Three-Station Switch Connections.

I have noticed several times diagrams of connections for controlling incandescent lamps from several points, but I have never seen the arrangement shown by the accompanying diagram, and therefore submit it as being of interest possibly to other readers. The switches are the ordinary single-pole, two-way snap switches, connected as clearly shown. The lower lamp and switch are located on the ground floor of a residence, the middle switch half-way upstairs, and the upper switch and lamp in the upper hall. On entering, the lower lamp is lighted by throwing the switch on that floor; when



THREE-STATION SWITCH CONNECTIONS.

half-way upstairs, throwing the middle switch extinguishes the lower lamp and lights the one above, and upon reaching the upper hall, throwing the switch there extinguishes the lamp. This operation may be repeated by the next person coming in, indefinitely, and it may be reversed after any cycle upward, starting at the upper switch and lamp and passing downstairs. The advantage of the arrangement is obvious, and it is the simplest one I know of for accomplishing the results described.

Tacoma, Wash. A. R. Haynes.

*Through an error, the battery and one of the buttons at station B have been omitted from the diagram.—Editor.

Mr. Ryder's Transformer Trouble.

Referring to Mr. Ryder's transformer trouble described by him in the last issue of the American Electrician, I would suggest that the primary circuit of the transformer on the left of his diagram was open. In that case, there would evidently be no voltage, across the secondary terminals *B* and *C*, and with three lamps connected across either *A* and *B* or *A* and *C* this secondary current from the "live' transformer would have to pass through half of the secondary winding of the "dead" one. The counter e.m.f. of this coil would cut down the voltage actually delivered to the lamps.

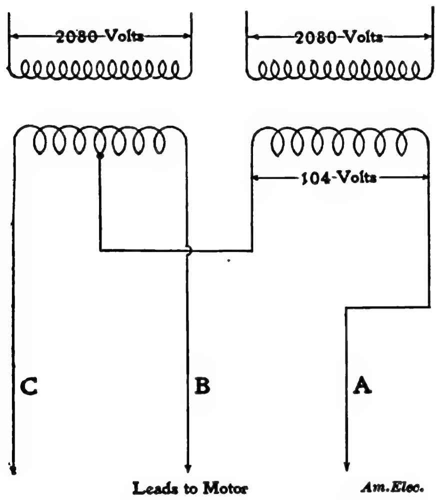
Granite, Ill. Harry C. Coates.

Mr. Ryder's transformer trouble could have been due to the primary fuses of the transformer *B-C* being blown, leaving that transformer dead. Under this condition, a lamp connected across *A* and *B* would receive practically full voltage because the reactive effect of the half of the secondary

B-C would not be high enough with so small a current to cut down the voltage appreciably. Adding more lamps, however, would increase the current through half of the dead secondary winding, and increase its choking effect, thereby reducing the voltage at the lamps. The same is true of lamps connected across *A* and *C*, while no voltage at all would be obtained across *B* and *C* because there would be no primary current in that transformer.

New York. JOHN D. GILBERT, JR.

Referring to Mr. Ryder's transformer trouble, I would suggest that it was due to the primary of the transformer *B-C* being open, probably at the fuse-block. Under this condition, with lamps connected across *A* and *B* or across *A* and *C*, one half of the secondary of the transformer *B-C* would be



MR. RYDER'S TRANSFORMER TROUBLE.

in series with the lamps and act as a choke coil to reduce their voltage; this choking effect would, of course, be greater as more lamps were connected up, reducing the effective voltage still further. The opening of the primary of the left-hand transformer would also explain the absence of secondary voltage across *B* and *C*.

HENRY MULFORD.

Patchogue, L. I., N. Y.

[The foregoing explanations of Mr. Ryder's trouble are correct. The correct cause of the trouble was also explained by Messrs. F. W. Cerny, Mesa, Ariz.; Fred. R. Price, Columbus, Ohio, and C. C. Webster, Schenectady, N. Y., in briefer form.—EDITOR.]

Questionable Solutions.

I wish to call attention to Mr. L. P. Brode's solution to my problem in storage-battery connections which appeared in the June number. In this diagram, the wrong polarity will result when the portable cells are charged from the cells *XYZ*. When the latter cells are in series with the portable cells the connections shown are right, but when cells *XYZ* charge the portable cells *P* the polarity is reversed. This is also true of the other solutions.

Brookline, Mass. E. L. LINCOLN.

I think that some of the solutions printed in this department of the June number are questionable.

As shown in solutions of Mr. Turner's problems in telephone connections by Messrs. Brode, Bethel and Malcolm, in ringing a station via ground return, part of the ringing current will also branch through one of the stations and ring back on the other side of the line to the third station, to ground, thus ringing the whole three stations. Mr. Brode's solution seems to be the best offered.

Mr. Petry's problem of bells operated from 110 volts is not feasible, as answered by Mr. Bethel and Mr. Dillon, in the June number, unless high resistance bells are used. In Mr. Bethel's solution, the voltage would be too high, which, with a few low resistance bells, would cause excessive sparking, and with high resistance bells, the ad-

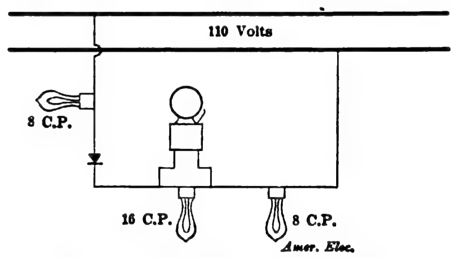


FIG. 1.—MR. LOVELAND'S SOLUTION.

dition of condensers or high resistance, non-inductive resistances bridged around the bells would be needed, for the same reason. Mr. Dillon's solution would not be practical for more than three or four bells, and would also spark. Both solutions are open to the objection that the Fire Underwriters would make to running high voltage without any resistance on low insulated apparatus, such as bells and buttons. There is a slight error in the drawing, as shown in the solution by Mr. Merrill, but the scheme is more commendable, both for safety and practicability. I might add that I have operated low resistance bells on both direct or alternating 110-volt circuits by the method shown in Fig. 1. For large bells, increase either one or both of the two outer lamps as needed.

Philadelphia, Pa. W. A. LOVELAND.

Question Regarding Motor Control Starting Apparatus.

Referring to the article in the June number on "American Types of Control Apparatus for Direct-Current Motors," the author states that the arrangement shown in Fig. 2 is being superseded by that shown in Fig. 1.

The writer installed and started a 20-h.p., 220-volt motor recently, the starting box of which was connected up as shown in Fig. 1. Upon starting the motor light it seemed to act normally, except that there was too much flashing on the contacts of the starting box the first two or three steps. Upon putting on a belt connected to a countershaft, which represented probably 6 per cent of the rated load, the motor would make a few revolutions and then stop, the armature taking a very heavy current, of course, as there was no circuit-breaker in circuit, except an ordinary fuse.

The rheostat being of different make than the motor manufacturers had been sending me, I examined the internal connections and found them as in Fig. 1. I changed the field connection so as to make it correspond to that shown in Fig. 2, and the motor would then start under full load with apparent ease.

With connections as shown in Fig. 1 there is no field until the starting arm reaches the first step, and then the whole e.m.f is impressed instantaneously on the armature terminals. There being no field, practically, as there is an appreciable time element in building up the field, there is an extra heavy rush of current in the armature which seems to neutralize or react on the field

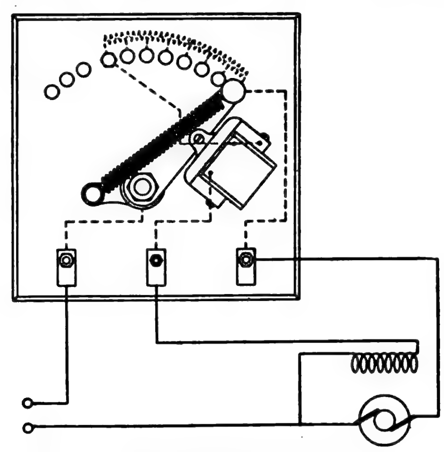


FIG. 1.—QUESTION IN MOTOR CONTROL.

in such a manner as to prevent it from building up. The line drop in this instance is not sufficient to account for the action of the motor.

After changing the starting box connections we had a full field as soon as the main switch was closed. This prevented such a sudden rush of current through the armature, and gave it time to speed up and produce the counter electromotive force necessary to hold the voltage up at the field terminals.

The above explanation of the action of the current in the two instances may be crude, but I believe it is, in the main, correct. If so, why are the connections in Fig. 1 advisable?

Alamogorda, N. M. M. H. FISHER.

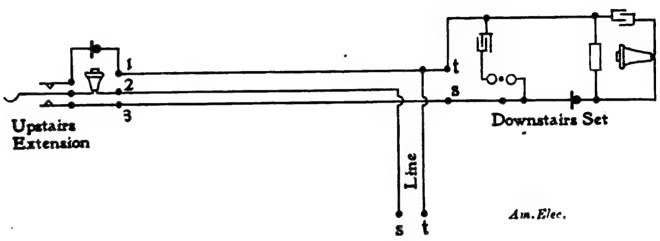
We Stand Corrected.

I note in your "Questions and Answers" of the June number the query as to the difference in the induction coils in the Stromberg-Carlson system and those in the Hayes system, 24 volt. The answer stated that there is no induction coil in the instrument in the Hayes system, but there are repeating coils at the exchange. I beg leave to correct this statement as the Hayes system uses both the induction coil at the subscriber's station and the repeating coil in the cord circuit of the exchange. The difference in the induction coils of the two systems is that in the Hayes system the secondary side of the coil is bridged with the condenser. This gives what is generally called condenser transmission. The charged condenser is the virtual local battery for

the varying resistance of the transmitter.
La Crosse, Wis. C. D. ENOCHS.

Extension Telephone Trouble.

I have a telephone of the central-energy type in the lower part of my house, and have connected an extension set in the upper story, both sets being represented by A and B, respectively, in the accompanying sketch. B was connected so that a conversation carried on at A could be heard by having the receiver at B in series with the sleeve (S) side of the line, with the



EXTENSION TELEPHONE TROUBLE.

hook-switch down. The transmitter and receiver are in series with each other and bridged across the line when the hook-switch is up. By raising the hook-switch at B, A should be cut out of circuit. Disconnecting lines 1 and 3 at the binding posts and holding a receiver to the ear, causes a faint buzzing to be heard. If the shield of B is touched, this buzzing is intensified. According to the circuit, A should not be able to hear a conversation carried on at B; but one can hear indistinctly what is being said at B. The three wires from A to B are run outside the building a distance of about ten feet and are not on insulators. I would like to have some of the readers of the AMERICAN ELECTRICIAN offer their opinion as to the cause of this trouble and its remedy.
Cleveland, Ohio. H. M. WOLF.

Peculiar Static Effect.

I was recently called into the office of a specialist on static treatment to remedy a peculiar fault. It appears that in treating patients their hands and faces would at times become black, especially if the weather were cold. I made a thorough examination and found that this peculiar condition only occurred when the chair was positive and the crown over the head negative. Searching around for a probable cause, I discovered that there were open fireplaces with five oil heaters used to keep the room warm. The minute carbon particles given off by the burning oil could, of course, not be seen; but their presence was evidenced in the faces and hands of the patients. By reversing the polarity of the chair and crown, the phenomenon could not be obtained, nor could it be duplicated on days when the oil stoves were not burning.
Washington, D. C. C. W. PETRY.

Electric vs. Hydraulic Elevators.

I have noticed from time to time various articles in the technical press comparing the electric and hydraulic elevators, and give herewith my own observations regarding the cost of operating and repairing both types. We have in operation here a direct-connected electric elevator supplied with 500-volt direct current from the circuits of the local electric light company. This elevator has been in operation for 3 years and 6 months, six days in the week. During that time it has never been shut down for repairs, and the total amount of money spent on it has been about $4. We purchase power on a flat rate of $15 per month. Hydraulic elevators in this vicinity cost about five cents per trip irrespective of repairs. Of course there are electric elevators on the market which require more care than others; but ours is both reliable and economical.
San Antonio, Texas. R. E. WITTING.

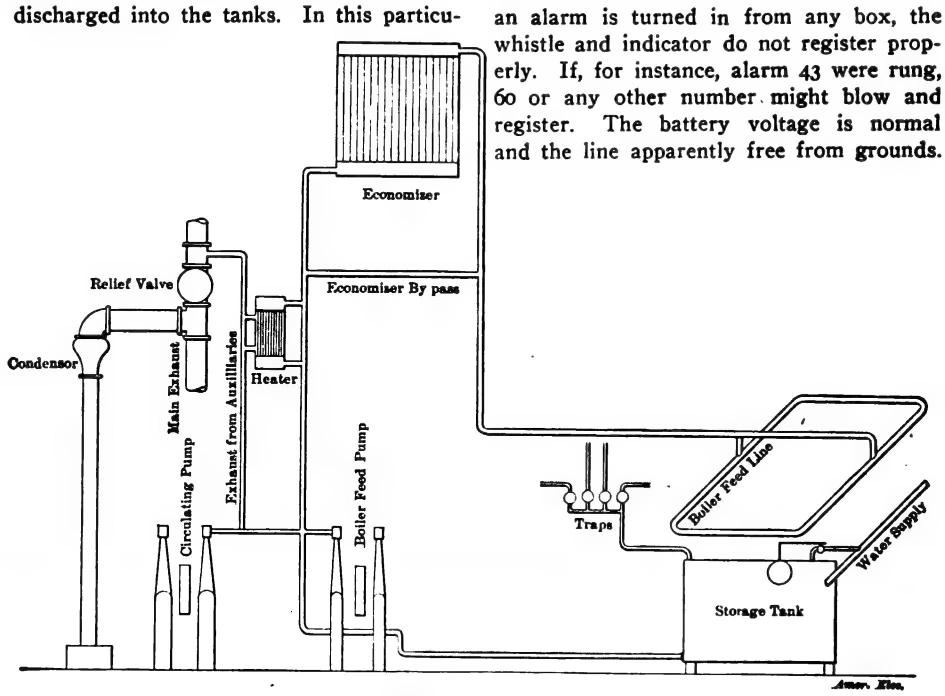
Feed-Water System of a Large Power House.

Herewith find a diagrammatic layout of the feed-water system of one of the large power houses in New York City.

It will be seen by reference to the engraving that the water enters the building through the pipe marked "water supply" and passes into a storage tank through a ball-cock which governs the quantity of water discharged into the tanks. In this particular installation there are nine tanks, each supplied from the main through a ball-cock and connected together by means of an equalizing pipe which is provided with all necessary valves for the purpose of cutting out any desired tank. The sketch shows the piping for one unit, each unit being a duplicate of the other and being cross-connected so that any set of pumps may be used to supply any heater or economizer. Any unit in the system may, of course, be cut out without in any way causing inconvenience.

After leaving the feed pump the water passes into a closed heater, thence through the economizer into the boiler feed line. From this line branches lead directly to the boilers. It will be noticed that by-pass piping is provided for cutting out the heater or economizer, or both. Attention may be called to the fact that the exhaust from all the auxiliaries is passed through the heater before entering the main exhaust pipe to the atmosphere. Traps on the drains from the high-pressure steam line may be discharged into the storage tanks as shown, thus getting the benefit of all of the water of condensation as well as the heat contained therein.

No attempt has been made to show any of the valves, etc., the purpose of the sketch being principally to show a desirable general arrangement or order of continuity for the water from the main to the boiler branches. The number and location of valves may be varied to suit the ideas of the designing engineer or to conform to the depth of the owner's pocketbook.
Brooklyn, N. Y. THOMAS P. MORGAN.



FEED-WATER SYSTEM OF A LARGE POWER HOUSE.

Fault in Fire-Alarm System.

About three years ago there was installed in this town a Gamewell fire-alarm system. The wires were not soldered at any of the connections and the work was performed in a very slipshod fashion, with the result that we have had trouble now and then. If an alarm is turned in from any box, the whistle and indicator do not register properly. If, for instance, alarm 43 were rung, 60 or any other number might blow and register. The battery voltage is normal and the line apparently free from grounds. I would like some of your readers to consider the problem and tell where the trouble might lie.

H. C. PARRISH.
Great Barrington, Mass.

Questions and Answers

Inquiries not accompanied by the name and address of the inquirer, will not receive attention.

What size of wire should be used to connect up a 110-volt, 1-h.p., alternating-current motor 25 feet from the source of current? M. H. B.

No. 12 wire, B. & S. gauge.

How much power will a 45-inch Sampson turbine give under a head of 15 feet? What will be the approximate speed? W. R.

About 238 horse-power at 140 revolutions per minute.

Why is it necessary to use one cored carbon in an alternating-current arc lamp? H. F. K.

Because with solid carbons the arc wanders, or travels around the edge of the carbon tip; the cored carbon centers it.

Please give data for a jump spark coil. F. H.

Presuming that you have in mind a coil for gas engine ignition, the data are as follows: Core, 1½ inches diameter and 8 inches long; winding, 13 layers of No. 16 double-cotton-covered magnet wire.

How many cells of gravity battery would be required to charge four small storage cells? (2) Should the gravity battery be connected to the storage cells all the time? L. L. T.

If the storage cells are in series, use 20 gravity cells in series also. (2) Yes, if the storage cells are to be used at all frequently.

Is static electricity unidirectional or alternating in character? (2) What is its probable tension, and if alternating, its frequency and wave form? W. N. S.

It depends on conditions. A discharge from a static machine is unidirectional; a lightning discharge is oscillatory. (2) The tension is whatever it is made, in the case of artificial static charges and discharges.

A rotary converter receives 420 volts alternating and delivers 650 volts direct current; is there a gain of power? E. J. K.

Certainly not; volts alone do not represent power. The delivered *watts* are from 3 to 10 per cent. less than the watts received at the alternating-current side, and power is measured in watts.

I am told that it is impossible practically to transmit small powers over considerable distances—two horse-power over a distance of three, five or ten miles. Is this true, and if so, why? R. S.

It is not at all impossible, but the cost of the line makes it commercially impractical. The power could not be sold at a price that would pay interest on the investment and a profit on the cost of power production.

What size of cable or wire must be used to carry 80 amperes 119 feet with not more than 3 per cent. drop; the voltage of the circuit being 240? W. F. R.

The smallest size allowable under the Fire Underwriters' Rules is No. 2 rubber-covered or No. 4 weatherproof; the drop will be considerably less than 3 per cent. with No. 4 wire and still less with No. 2, of course.

Can a 500-volt, shunt-wound motor, rated at 1.05 amperes, be changed to a series-wound machine successfully? There is a single field coil of No. 30 s.c.c. wire. C. C., Jr.

You might try rewinding the field coil with No. 20 s.c.c. wire, making the new coil occupy the same space now occupied by the shunt coil. The speed will, of course, be greatly reduced by the resistance of the new field coil in series with the armature.

I have three ordinary vibrating bells arranged to be rung simultaneously from any one of three push-buttons, as shown by the accompanying sketch (Fig. 1), and wish to add a button to ring No. 2 bell alone. Can it be done? W. T. K.

Yes; by using a double-contact push button connected as shown by Fig. 2.

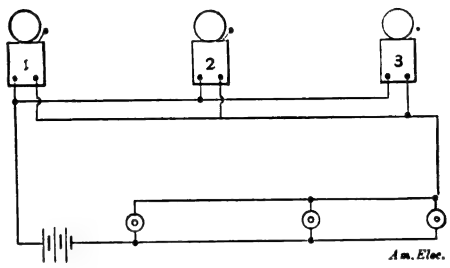


FIG. 1.

What size and type of motors and batteries should be used on the electric buckboard described last month? (2) Can any of the parts be bought already made, and where? (3) What is the approximate cost of building the complete buckboard? H. A. F.

The motors are described in this issue and the remaining parts will be described next month. (2) Not so far as we are aware. Parsell & Weed, of this city, however, are arranging to manufacture most of the parts. (3) We do not know.

What is the rule for the reactance of the single wire of a wide loop carrying alternating current, such as a series arc lighting circuit? (2) What is the corresponding rule for a trolley wire with grounded track return? G. K. M.

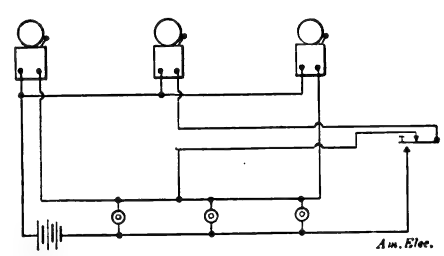


FIG. 2.

There is no formula applicable to such a case. The inductance might be approximated by computing the inductance of short sections of the line by the ordinary formula based on magnetic flux, and adding the results; the reactance is equal to 6.2832 × frequency × inductance. (2) The same as for two parallel wires the same distance apart, except that the track half of the circuit must be considered as magnetic material.

What is the dark deposit that appears on the interior wall of an incandescent lamp bulb after long service? (2) Can the rotational direction of a polyphase induction motor be changed by changing the stator connections? (3) In starting a large induction motor, is the current admitted gradually as in the case of a direct-current machine? L. F. F.

Carbon, from the filament. (2) Yes; if a two-phase motor, reverse the connections of the two leads in one phase; if a three-phase machine, reverse any two of the three primary leads to the machine. (3) Yes, in most cases. In some, however, an auto-transformer is used to deliver a low voltage for starting, and the machine is thrown directly on the full voltage after it gains good momentum.

Is it possible to dispense with platinum leading in wires in incandescent lamps and use a cheaper metal? J. B. N.

Yes, we described some months ago a patented lamp in which copper was used successfully.

What is the relation between an alternating current and a direct current capable of heating a given wire to the same temperature? (2) If the two currents have different values, why is it? (3) Why is it desirable to put external resistance in the armature circuit of an induction motor? J. S.

The alternating current must have a mean effective strength equal to the steady strength of the direct current to produce the same heating effect in a non-inductive conductor; the maximum strength of the alternating current, therefore, is 1.4 times the strength of the direct current. (2) The effective values are not different. (3) In order to cut down the rush of starting current, as in a direct-current motor, and also to improve the power factor of the motor at starting.

How can a dynamo built to give 50 volts and 80 amperes be changed to run as a 110-volt motor? The armature is wound with 55 coils of 2 turns each, the conductor being 4 No. 13 wires in parallel. (2) How can the buzzing in telephone receivers, due to the ringing generator, be obviated? E. F. H.

Rewind the armature with 110 coils, each having two turns of two No. 13 wires in parallel and cut out one coil, leaving 109 coils active. Substitute a commutator having 109 segments. Rewind the field with wire three gauge numbers smaller than that now on it making the new coils fill exactly the same space now occupied by the old ones. The speed will be about 10 per cent higher. (2) Only by putting in a different generator built especially for the purpose by a standard manufacturer.

Is the humming in an alternating-current magnet and its armature due to the vibrations of the laminations or to the rattling of the movable parts of the mechanism? (2) Is the core laminated to prevent eddy currents in it or loss by hysteresis? (3) Does it matter if the armature of an alternating-current magnet is reversed in its relation to the poles after it has been in service some time? J. N. L.

Both, but the mechanism usually causes most of the humming. (2) To reduce the eddy currents in the core. (3) Not at all.

What is the difference between foot-pounds and pound-feet? N. B. S.

The foot-pound is the unit of work done in moving a mass through a distance; multiplying the pressure (in pounds) against which a mass has to be moved (including its own weight if the motion be vertical) by the distance (in feet) gives the work done in foot-pounds. The pound-foot is the unit of angular torque; if a pull of 10 pounds is required at the periphery of a wheel three feet in diameter in order to turn the shaft on which the wheel is secured, the torque will be 10x1.5 = 15 pound-feet.

NEW TYPE OF MOTOR-STARTING RHEOSTAT.

Fig. 1 herewith shows a new type of motor-starting rheostat, brought out by C. W. Landers, of San Francisco, Cal., whose object was to design a motor-starting device that would not stick after use for some time, but could always be relied upon to release when the current is shut off or fails. The illustration is nearly self-explanatory. The cast-iron frame forms the back and top of the starter and the resistance takes the form shown. A rod attached to the hand lever passes through the cover and through all the resistance coils and has a disc attached to its lower end. As the handle and rod are raised this disc picks up the coils one by one and short circuits them. When the handle reaches the top it is held by the retaining magnet, the resistance coils being all cut out and held firmly together. The maker claims several points of merit over existing starters, chief among which is the manner in which the resistance wire is mounted on the frame. This is said to produce a magnetic flux which extinguishes the arc when the circuit is broken. No arcing is said to be perceptible between the plates of the resistance coils, but in the large sizes the plates are provided with carbon trailers mounted on the disc surfaces. By removing the handle and the retaining magnet, and substituting a solenoid lifting coil at the top of the controller and attaching the plunger to the lifting rod and dash-pots at either top or bottom of the rod, an automatic motor starter results. It will be noted that when used in this manner the weight that the solenoid will be called upon to lift is at first small and increases as the solenoid increases its pull. The device is said to be positive in action at all times.

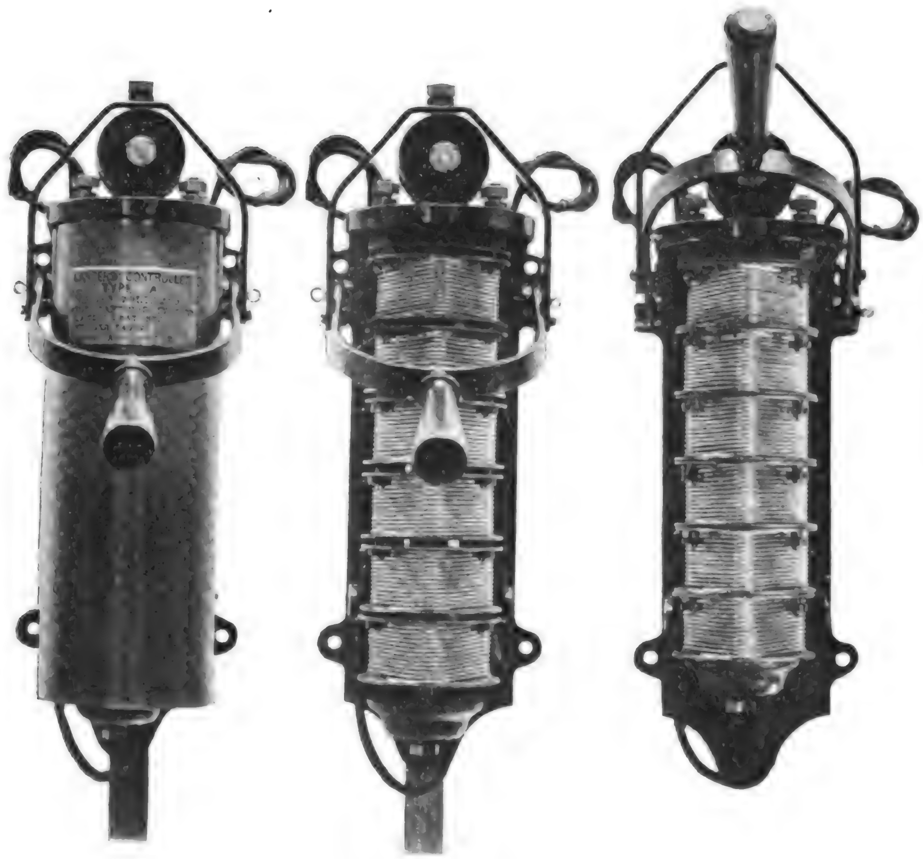


FIG. 1.—LANDERS MOTOR-STARTING RHEOSTAT.

CARBON REGULATOR FOR AUTOMATIC BOOSTER CONTROL.

During the past year the Electric Storage Battery Company has developed and standardized a new method of automatic booster control for regulating the charge and discharge of batteries installed for rapidly fluctuating railway work. This special apparatus, which has been perfected for this purpose, is what is known as the carbon regulator. It consists of a number of piles of carbon discs which are subjected to the varying pressure of a lever, from one end of which is freely suspended the soft iron core of a solenoid which carries the entire generator load, while to the other end is attached a helical spring, whose tension may be adjusted by hand to counterbalance the pull of the solenoid at any desired load on the machines. Slight variations of load above or below this amount will cause changes in pressure on the carbon piles resulting in wide variations in their contact resistance. Advantage is taken of this resistance variation to control the field excitation of the battery booster, usually through the intermediary of a small exciter between whose fields and the carbon piles connections are made similar to those of a Wheatstone bridge, the current in the exciter fields varying in direction and amount with changes in the pressure on the carbon piles. This regulator, while simple in construction and mechanically rugged, is found to be exceedingly sensitive, and a very small proportion of the load fluctuations on a railway plant, getting back to the generators through the solenoid, will cause the battery to charge and discharge, relieving the machinery of the balance of these fluctuations.

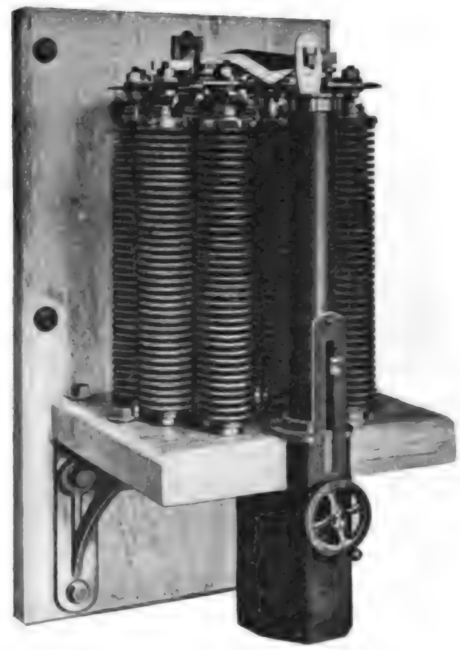


FIG. 1.—CARBON REGULATOR.

The constant load falling on the generators may be adjusted at any desired point by adjusting the tension of the spring above mentioned, which adjustment is instantly made, and may be altered from time to time during the day to meet changes in the load conditions; the battery either simply "floating" or taking a continuous peak discharge or a net charge, according to the adjustment, while always taking automatically the momentary fluctuations of load. The regulator, which is illustrated by the accompanying engravings, occupies about the same space on a switchboard as a watt-hour meter. Fig. 2 shows the solenoid in the generator circuit at the back of the board.

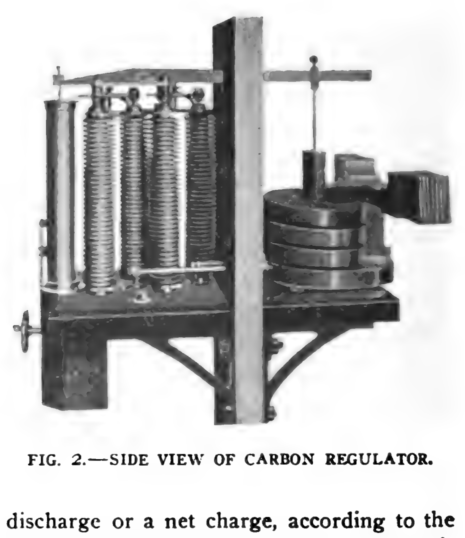


FIG. 2.—SIDE VIEW OF CARBON REGULATOR.

New Apparatus and Appliances

BELT-TYPE, ROTATING-FIELD ALTERNATORS.

A line of belted-type, self-contained, rotating-field, alternating-current generators, such as shown herewith, has recently been placed on the market by the Westinghouse Electric & Manufacturing Company. The machines are built for single, two and three-phase circuits, in sizes from 30 to 200 kilowatts. The single-phase generators are manufactured for 220, 440, 1100 and 2200-volt circuits at 7200 alternations, and besides these the polyphase machines are wound for 6600 volts and both 3000 and 7200 alternations.

The frame of the stationary armature is cast in one piece with slots machined on the inside for holding the punchings which receive the windings; these are composed of wire, strap or bars, depending on the size and voltage of the generator. Open slots are employed in machines up to 75 kilowatts, with coils held in place by hard fibre wedges. In the larger machines partially closed slots are used. Horizontally split brackets which carry the bearings are bolted to this cast-iron frame. The bearings are generous in their dimensions and are self-oiling, having oil rings and an oil gauge with large foundation areas and suitable belt tighteners. These generators may also be arranged for direct connection to an engine or water wheel.

The fields of the smaller generators are of cast steel with pole caps of the same material. The poles of larger sizes are laminated and keyed or dovetailed to a cast-iron spider. The field coils are composed of square wire so wound as to expose the maximum surface. In the generators having laminated poles heavy brass wedges, which hold the field coils in place, retard any shifting of the field between the poles, insure satisfactory parallel operation of two and thus, it is claimed, practically eliminate pumping between the generator and any rotary converters or synchronous motors which may be connected in the system and or more generators.

FIG. 1.—ROTATING FIELD ALTERNATOR.

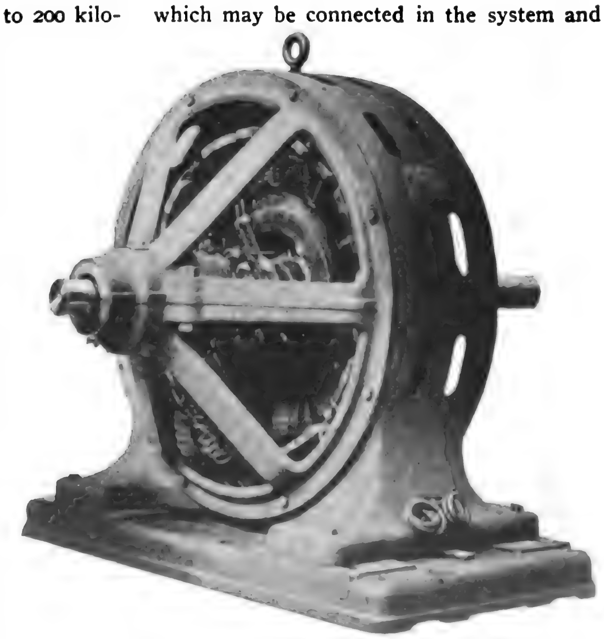


FIG. 2.—ROTATING FIELD ALTERNATOR.

Every means has been utilized for the rapid dissipation of heat from the machines. Open spaces in the laminated field register with those in the armature, and during operation air is drawn in through the field spider and forced out through the stationary core and windings, thus insuring low operating temperature. Excellent regulation is said to be obtained by properly proportioning the armature and field windings in preference to saturating the magnetic field.

The single-phase generators have compensating field windings supplied with rectified alternating current. A commutator on the shaft adjacent to the collector rings has its brushes connected to the secondary of a series transformer in the armature circuit and its segments to the self-exciting field coils. The compensating winding is so designed, the maker claims, that the generator can be adjusted for a practically constant voltage from no load to full load or for an increase in voltage.

FAINT PRAISE.

In the description of the Fort Wayne Electric Works prepayment meters which we published last month, the statement was made that the meters were said to be "reasonably reliable and accurate." This was intended to read "unusually reliable and accurate."

A NEW FOUR-VALVE ENGINE.

The Atlas Engine Works, of Indianapolis, have recently placed on the market a new type of four-valve engine, in which especial attention has been given to the matter of steam economy; and a number of very radical improvements have been made with this in view. Chief among these is the placing of the steam and exhaust valves directly in the cylinder heads, rather than at the top and bottom of the cylinder. This results in a reduction of practically 4 per cent. in the clearance, and the saving of steam effected in this way is quite material. This also involved keeping the entire top of the cylinder and the upper portion of both heads constantly in contact with live steam, in this way greatly reducing the loss from cylinder condensation. The bell crank and toggle joint have been entirely done away with, and a great deal of the lost motion has in this way been eliminated. The steam valves are operated directly from a movable eccentric forming a part of the automatic shaft governor, and are entirely independent of the exhaust valves. The latter are operated from a fixed eccentric on the main shaft, in this way insuring uniformity of compression under all conditions of load and pressure. The connections are all of the "straight line" type, and involve no multiplicity of parts. Both the steam and exhaust valves are double ported, and it is claimed that practically no wire drawing of steam exists in this type of engine. Various tests are claimed to indicate a steam consumption practically identical with an engine of the Corliss type and a regulation of

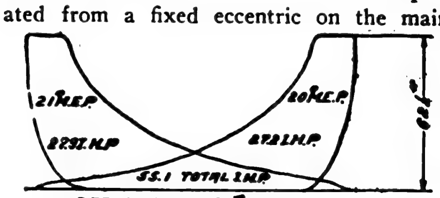


FIG. 3.—CARD FROM FOUR-VALVE ENGINE.

from 1 to 1½ per cent. under changes of load from friction to full rated capacity.

CIRCUIT BREAKERS FOR SPECIAL PURPOSES.

As is very generally known, the Cutter Electrical and Manufacturing Company, of Philadelphia, Pa., manufacture many lines of standard I-T-E circuit-breakers, which are very familiar to the trade. Many special designs are, however, often required to deal with conditions out of the ordinary run of practice, so that a brief description of a tew ot these will not be amiss. Where generators are operated in multiple, in case of accident to one of them or failure of its prime mover, the affected unit is liable to injury from motoring and its fellows are seriously overloaded. To provide against such contingencies the "Reversite" circuit-breaker shown by Fig. 4 was designed. This instrument serves to automatically disconnect the crippled generator before it becomes a tax upon those carrying the load, or before it has attained a dangerous speed due to running as a motor. The results are obtained without the use of relays. A limit switch for the protection of rotary converters is shown by Fig. 5. Where a number of rotaries are connected in multiple on the direct-current side, failure of the current supply of one or more of them, will cause each unit to run as a motor, taking power from the direct-current system. The limit switch is designed to prevent this. The operating coil of this type of instrument is of numerous turns and high resistance, and so connected that when the rotary attains abnormal speed the coil is brought into circuit across the line by a centrifugal device attached to the shaft of the rotary. The instrument illustrated is of 7000 amperes capacity, and is one of a number employed in the sub-stations of the New York Edison Company. Fig. 6 shows a double-pole circuit-breaker having a maximum capacity of 10,000 amperes at 250 volts. It is 30 ins. high, 24 ins. wide, and has a maximum depth of 20 ins. to the top of the operating handle. The illustration shows how space is economized by using for switch contact surface both sides of the terminal bars. The powerful toggle-operating mechanism is easy-working. Fig. 8. shows a triple-pole over-load circuit-breaker used for the protection of a three-phase alternating-current generator. It is provided with tripping mechanism in each of the two outside poles so that an over-load on any phase will cause the opening of the circuit. The

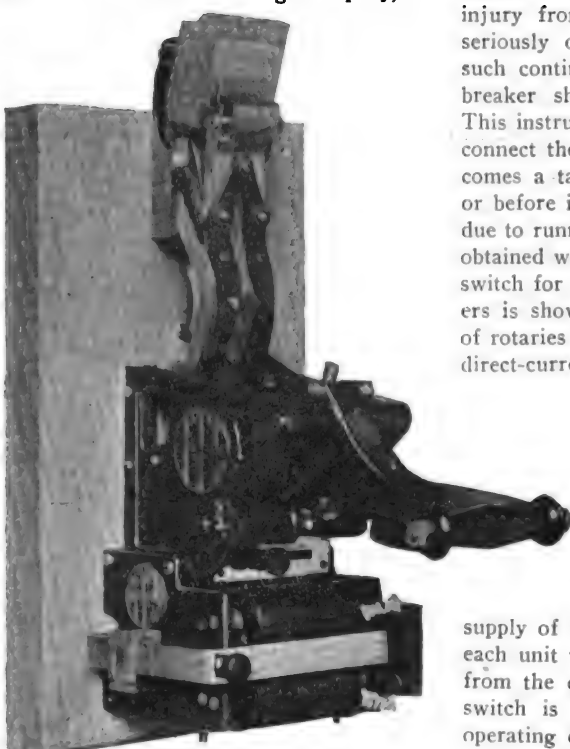


FIG. 4.—"REVERSITE" CIRCUIT-BREAKER FOR OVERLOAD AND REVERSE CURRENT.

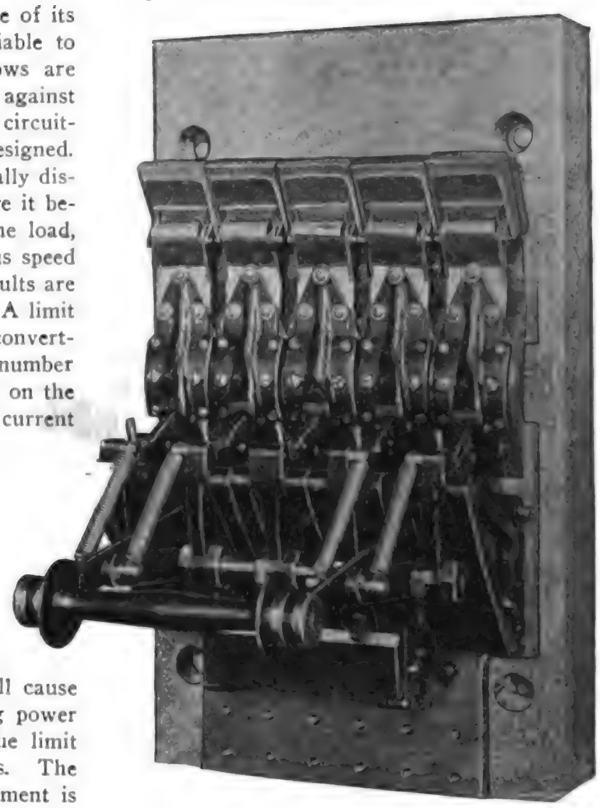


FIG. 5.—CIRCUIT-BREAKER FOR ROTARY.

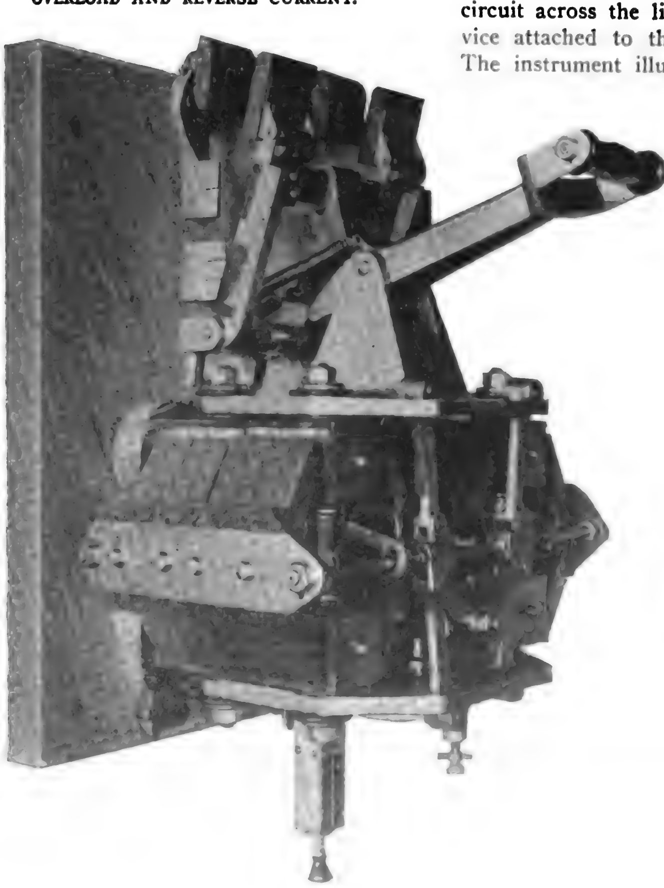


FIG. 6.—LARGE CAPACITY CIRCUIT-BREAKER.

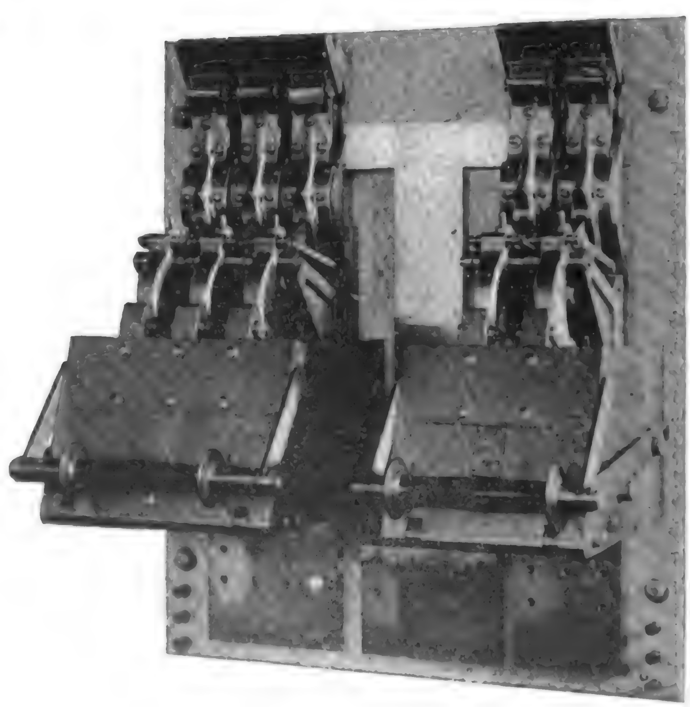


FIG. 7.—REMOTE CONTROL SWITCHES FOR EQUALIZER CIRCUITS.

breaker is also adapted to protect three-phase feeders and three-wire direct-current systems. The closing force is applied through a double toggle. This reduces the strain upon the insulating yoke which unites the poles. A remote-control circuit-breaker for controlling equalizer circuits is shown by Fig. 7. The right-hand switch is of 2000 amperes, the left-hand of 3000 amperes capacity. The upper terminal of each connects with the equalizer main, which takes the place of the equalizer bus otherwise required at the switchboard. The closing magnet is of exceedingly simple construction, and is designed to produce the required force with a minimum expenditure of energy. The exciting coil is liberally proportioned, and its entire exterior surface being exposed to the air, it is not liable to undue heating even as the result of frequent use. The closing and opening coils are brought into circuit by the respective movements of small double-throw switches located upon the switchboard. Remote control switches are also meeting with growing favor as a means of controlling generator, booster and feeder circuits from a distance.

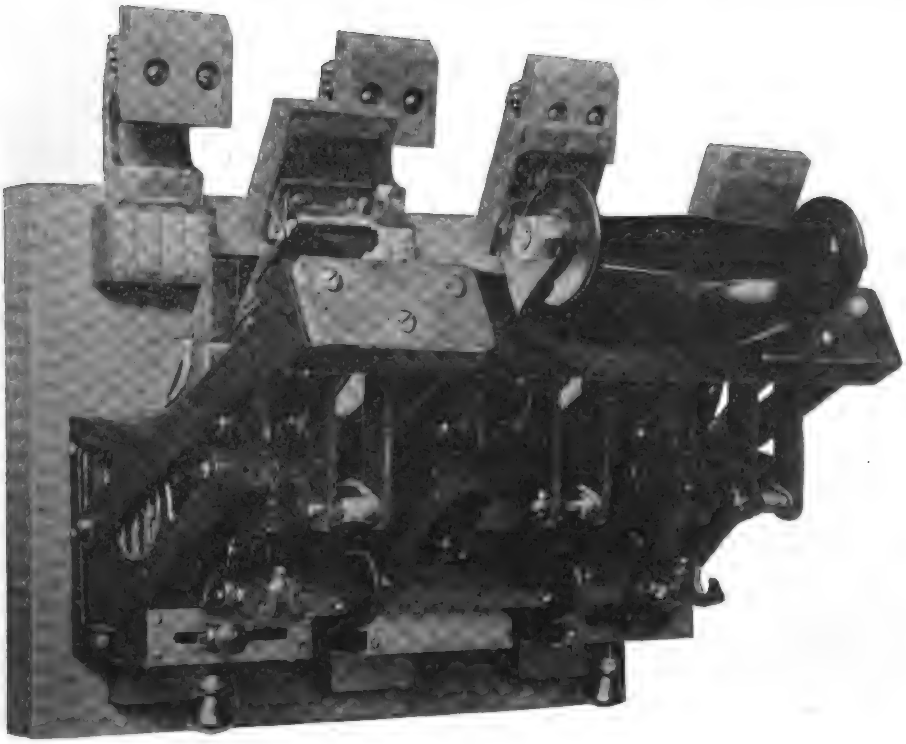


FIG. 8.—TRIPLE-POLE CIRCUIT-BREAKER WITH TANDEM TOGGLE CLOSING MECHANISM.

LIFTING MAGNETS.

The Electric Controller & Supply Company, of Cleveland, Ohio, has designed, built and tested magnets for handling iron and steel in every form, including pig iron, light and heavy melting scrap, steel ingots, blooms, billets, slabs, plates, sheets, rails, structural shapes, spikes, rivets, cotter pins, etc. A single design of magnet is, of course, not adapted to handling the full range of material mentioned; but a different magnet is not required for every different kind of material. The pig magnet, shown by Fig. 9, for instance, will handle with equal efficiency pig iron, scrap, rivets, nuts or any similar material in bulk. The magnet is suspended from the hook of a crane, direct-current at any of the common voltages being employed for energizing the magnet. The magnet is lowered upon the material to be lifted, and the switch closed, thus causing the magnet to attract and hold the material, which may then be hoisted by the crane and transported to the desired point, when by simply opening the switch it is released. Comparing this method of operation with the common methods of connecting the load to the hook of the crane with chains, hooks or clamps, the saving in both labor and time is apparent; as, in general, the attachment of the magnet to the load, as well as the release of the load, may be accomplished by the crane operator without assistance, thus saving the labor of one or more men for prying up the material, attaching hooks and chains at the point of loading and additional men at the point of delivery for unhooking the load from the crane.

FIG. 9.—PIG-IRON LIFTING MAGNET.

TESTS OF A REEVES ENGINE.

Prof. R. C. Carpenter, assisted by Prof. H. Diederichs, both of Cornell University, have made a series of tests on an engine built by The Reeves Engine Company, of Trenton, N. J., for the purpose of determining its economy and mechanical efficiency, and to observe the general behavior of the engine under various loads and steam pressures.

The engine, a vertical cross-compound, was connected through about 25 feet of 4-in. pipe to two B. & W. boilers. This pipe was one size too small, but was the largest that could be obtained for connection. In order to minimize the effect that the resulting high steam velocity would have, a piece of 6-in. pipe about 30 inches long was interposed to act as a sort of reservoir just ahead of the throttle valve. About 20 feet of 7-in. pipe connected the engine to a Wheeler surface condenser.

A Carpenter throttling calorimeter, placed beyond the throttle valve, served to determine the quality of steam. The steam pressure was determined by a gauge connected next to the calorimeter. The speed was found by a continuous counter, and by hand counter as a check. The continuous counter readings were used in the calculations as being correct.

One Thompson indicator was connected to each cylinder, taking cards from each end by means of a three-way cock. Motion for the indicators was obtained by fastening a rod to each cross-head, the stroke being reduced by means of a reducing wheel fastened to each indicator. The condensed steam was pumped by the air pump alternately into two tanks on scales. Readings of condensed steam weights were taken every five or ten minutes, as the load demanded.

For the purpose of test the engine was fitted with a fly-wheel 5 feet in diameter on the low-pressure side. Upon this wheel was placed the Prony brake for the determination of the developed horse-power. This brake was, in all respects, of the ordinary standard design, the strap being of steel plate, fitted with wood blocks on the inside. The wheel was kept as cool as possible by running cold water constantly into the flanged rim, and taking it out by a scoop. A steady small stream of cylinder oil led under the strap helped considerably in the smooth operation of the brake. By these arrangements as much as 185 developed horse-power was taken off one brake. For the condensing series as high a vacuum as could be obtained was carried. This averaged about 24 inches. For the non-condensing series the air-cock on the condenser was kept open, insuring condensation under atmospheric pressure.

For the condensing runs the engine dimensions were 10½ inches and 20 inches x 14 inches; for the non-condensing runs, 12 inches and 20 inches x 14 inches. This change was effected by taking out a liner the new designs of condensers, now being manufactured by the W. H. Blake Steam Pump Company, of Hyde Park, Mass., were made to cover both types. The new standard designs range in capacity from 600 to water into the condenser and consequent flooding of the engine.

The construction of this machine is compact and simple, all parts are readily accessible. The condenser shown in the accom-

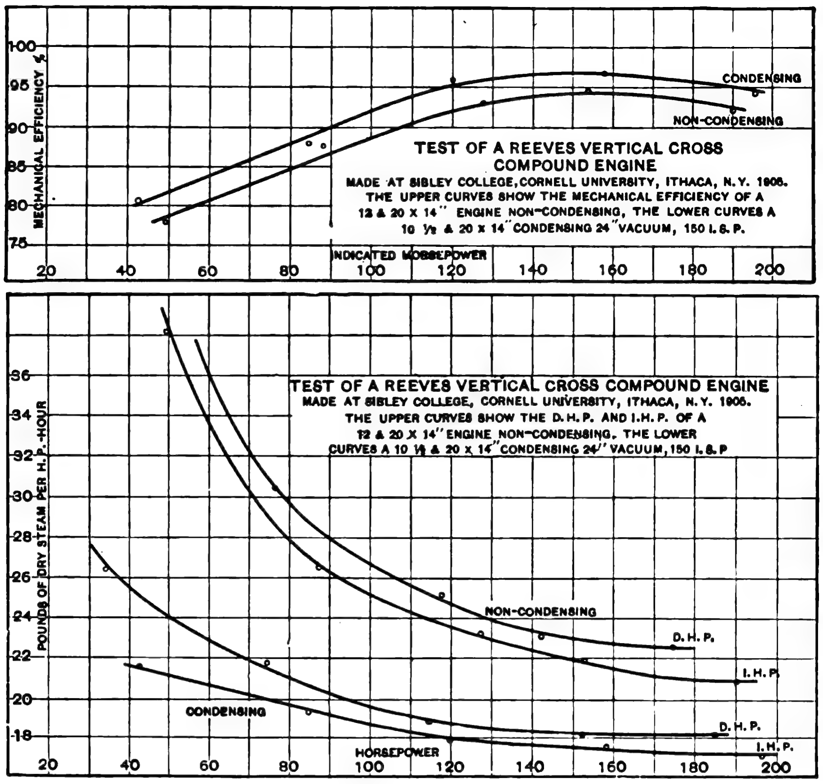


FIG. 10.—TEST CURVES OF REEVES ENGINE.

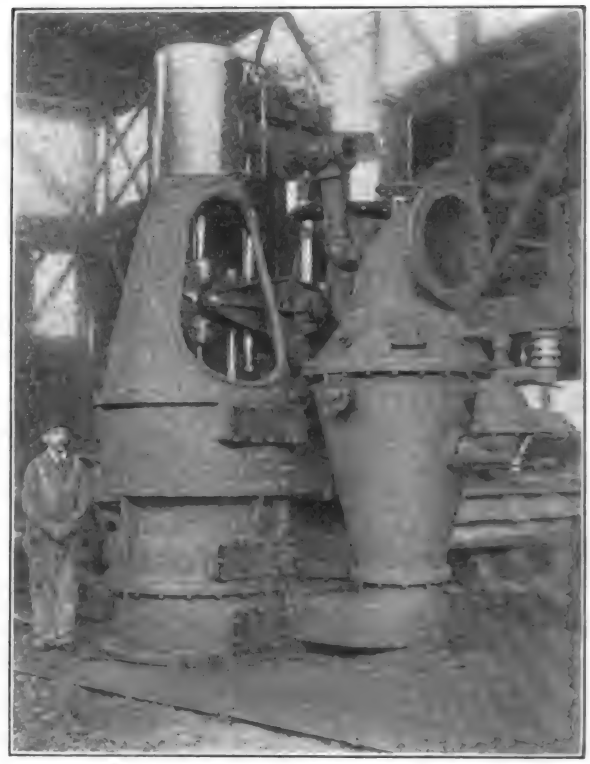


FIG. 11.—TWIN JET CONDENSER.

from the high-pressure cylinder. These dimensions make the cylinder ratio in the first case 3.60, in the second 2.75.

The developed horse-power was found by means of the formula: D.H.P. $= .001492\, n$ for every 100 pounds of net brake load.

The steam consumption per indicated horse-power and per developed horse-power for various loads and steam pressure was computed on the basis of dry steam.

For the purpose of facilitating inspection of results and discussion the water rates and mechanical efficiency are plotted on the accompanying curves (Fig. 10).

Two things are to be noted about these curves. The cut-off even at the high loads does not seem to be late enough to cause any marked rise in the steam consumption at overloads. In fact in most cases little or no rise could be determined. Again, the curves show good economy over a wide range of load. The mechanical efficiency curves show a steady increase with the load at any given steam pressure. On the overloads the efficiency falls off but slightly.

INDEPENDENT TWIN JET CONDENSER.

The advent of the independent air pump and condenser has had much to do with the practical development of the compound engine in medium and small sizes, for with this combination there are now obtainable economic results which not long since were expected only from the large compound engine with direct-connected air pump. That the jet and the surface type of condensers have their respective fields, is clearly recognized; neither type will meet all possible requirements. It was with this in mind that 40,000 pounds of steam condensed per hour with injection water at 70 deg. F. One type is illustrated herewith. The air pump is made with compound steam cylinders, as here shown, with the Blake automatic valve motion, when it is to be operated condensing, and with twin vertical steam cylinders when operated non-condensing and the exhaust steam utilized for feed-water heating or otherwise. The water cylinders are composition lined and all water piston (or bucket) heads are of the same material and fibrous packed. Easy access is afforded to heads, packing and water valves through hand holes on either side of the pump. A special composition is used in the construction of the water valve seats and guards and the studs and water piston rods are of Tobin bronze. The injection stem and cone are of composition, access to the same being provided through hand holes on either side. The amount of water passing through the condenser is regulated by the vertical adjustment of the injection cone which acts as a nozzle to form a thin spray, which is thrown out at an angle of 45 degrees. This falls upon a succession of shelves, thus forming secondary spray through which the exhaust steam from the engine must pass; instantaneous condensation results with economy in the use of water.

In order to prevent flooding of the cylinders of the main engine, an independent vacuum breaker attachment is secured to the side of the condenser; so that when the water reaches the level of the flood chamber the float is raised, and by great leverage forces the check valve from its seat, allowing an inrush of air which instantly breaks the vacuum, thus preventing further suction of

panying illustration is a twin vertical compound jet condenser of exceptional size, having a capacity of 64,000 lbs. of steam condensed per hour with the injection water at 70° F. It has steam cylinders 15 and 30 inches in diameter by 24 inches stroke, and the air cylinders are 38 inches in diameter. The injection inlet is 12 inches, while the discharge is a 20-inch pipe.

APPARATUS WANTED.

We are informed by Mr. W. I. Savidge, Macomb, Ill., that he is in the market for single-phase and three-phase induction motors and a considerable quantity of electric light supplies.

THREE-PHASE TRACTION TO BE INTRODUCED.

The Ganz system of three-phase alternating-current electric traction, which is well known in Europe, is to be introduced on this side. This system, for which much is claimed in the way of cheaper initial cost and operation over the electric railway construction methods at present in vogue in this country, is to be exploited by the Railway Electric Power Company, in which several New York capitalists and railroad men are primarily interested. The company has acquired the electric traction patents and manufacturing rights of Ganz & Co., of Budapest, for the United States, Mexico, Cuba and all the West Indies other than those under British supremacy.

Messrs. L. B. Stillwell, electrical director of the Interborough Rapid Transit Company, and Frank N. Waterman are the consulting engineers of the new company.

THE RISE OF A PROGRESSIVE ESTABLISHMENT.

Fifteen years ago Messrs. Willard W. Low and Thos. I. Stacey decided that there was room for a supply house whose policy would be entirely different from that then in vogue; consequently, the Electric Appliance Company, Chicago, was incorporated, and the business was established in a very small way.

The company also started out with the determination, which has never flagged, to handle only the best specialties.

The first quarters secured by the Electric Appliance Company were at 242 Madison Street, which comprised the first floor only. As the business increased it was found necessary to take in the basement, and about a year afterwards the two upper floors were added, giving ample facilities for handling the business, though it was growing every day. Six years ago it was found necessary, in order to handle the business, to engage larger quarters, and the double five-story building and basement at the corner of Van Buren and Jefferson Streets was secured. This was ample for about two years, at which time warehouse No. 2 was established at 165 South Canal Street, for the accommodation of cross-arms, insulators, electro-galvanized conduit and other heavy and bulky material. This arrangement worked out very nicely until the business had grown so that the company was in danger of losing, on account of being so crowded, its reputation for making prompt shipments. It was then decided that about double the floor space would be necessary. Accordingly last summer architects were given instructions as to what was required in order to make a model supply house handling the large volume of business at that time, also allowing for a considerable increase, and the building that the Electric Appliance Company now occupies at 134-136-138-140 West Jackson Boulevard is the result.

This building is six stories high with a large basement, and has a frontage of 100 feet on West Jackson Boulevard and 100 feet on Desplaines Street.

The general offices of the company occupy the entire second floor, one-half being given to the sales department and the other half to the auditing department.

The remainder of the building is given up to the large stock carried. Two freight elevators facilitate the handling of all material, and the company is in better shape than ever before to not only handle its present business, but to take care of a large increase.

NATIONAL ELECTRIC LIGHT ASSOCIATION CONVENTION NOTES.

THE LOCKE INSULATOR MFG. CO., Victor, N. Y., exhibited a line of its well-known high-tension insulators.

DUNCAN ELECTRIC CO., Lafayette, Ind., had samples of its line of direct-current watt-hour meters on exhibition, in charge of W. H. Sinks.

BUCKEYE ELECTRIC COMPANY, Cleveland, Ohio, was represented by L. L. Sawyer of the Cleveland office.

WESTERN DISPLAY COMPANY, of St. Paul, Minn., had a handsome reflective sign in the corridor adjoining the Convention hall.

WARNER ARC LAMP COMPANY, Muncie, Ind., displayed several types of its arc lamps, the merits of which were explained by Mr. W. F. Warner.

THE COLUMBIA INCANDESCENT LAMP CO., St. Louis, Mo., distributed an attractive leather match box as a souvenir. Mr. J. S. Lehmann was in charge.

BABCOCK & WILCOX COMPANY, New York, exhibited a model of its boiler in the rooms of the Onderdonk Engineering Company, who is its Denver representative.

AMERICAN ELECTRICAL SUPPLY COMPANY, Chicago, was represented by C. E. Browne, who distributed a very useful souvenir in the form of a celluloid hand-bag label.

REYNOLDS ELECTRIC FLASHER MFG. CO., Chicago, displayed the improved Reynolds and Reco electric sign flasher. Mr. I. A. Bennett represented the company.

OSBURN FLEXIBLE CONDUIT COMPANY, New York, showed samples of its well-known Flexduct conduit and distributed tasteful scarf pins.

BRYAN-MARSH COMPANY, Chicago and New York, sent E. H. Haughton to interest central station men in the well-known Imperial incandescent lamps manufactured by the company.

MOLONEY ELECTRIC COMPANY, St. Louis, Mo., was represented by T. O. Moloney, who explained the merits of the well-known line of transformers made by this company.

DEARBORN DRUG & CHEMICAL WORKS, Chicago, were represented by F. A. Earle, R. W. Francis and George R. Carr. Bottles of perfume extract were distributed.

CROCKER-WHEELER COMPANY, Ampere, N. J., distributed engraved invitations to the delegates to visit its Denver offices. The interests of the company were looked after by W. F. Sullivan, Julian Roe and R. E. Miller.

STANLEY INSTRUMENT COMPANY. Great Barrington, Mass., was represented by F. J. Alderson and F. C. R. Spence, who explained the new rotated jewel-bearing meters for alternating-currents brought out by the company.

THE NATIONAL BATTERY COMPANY, Buffalo, N. Y., had three complete cells connected in series, on exhibition, and various parts of its storage battery. The exhibit was in charge of J. W. Gillette.

THE HIGH-TENSION ELECTRICAL SPECIALTY COMPANY, of Newton, Mass., exhibited one of its high-tension, weather-proof, oil-break switches. These are adapted for 3,000, 4,600 and 6,900-volt systems.

NATIONAL CARBON COMPANY, Cleveland, Ohio, was represented by J. S. Crider, N. C. Cotabish, J. F. Kerlin and C. W. Wilkins. A pocket size electric battery lamp was distributed as a souvenir.

THE SWITCHBOARD EQUIPMENT COMPANY, Pittsburg, Pa., was represented by A. C. Savidge, who exhibited a line of circuit breakers and a protected panel for use on motor circuits.

ELECTRIC APPLIANCE COMPANY, of Chicago, sent its President, W. W. Low, to represent it at the convention. This company was recently compelled to erect a new and larger building to accommodate its rapidly increasing business.

SIMPLEX ELECTRIC HEATING COMPANY, Cambridgeport, Mass., was represented by James I. Ayer and C. W. Richards. The company had an interesting exhibit of heating and cooking appliances, including new treeing irons for shoeshop work and new "Indispensable" water heaters.

LAGONDA MANUFACTURING COMPANY, Springfield, Ohio, had on exhibit a line of boiler cleaners, tube cutters and tube cleaners, resetting machines and damper regulators. A celluloid pocket rule was given as a souvenir. T. P. Molloy was in charge.

PHILADELPHIA ELECTRIC MFG. CO., Philadelphia, Pa., displayed samples of its extensive line of copper hoods and deflectors, incandescent street lighting fixtures, screw glass insulators, arc lamp cut-outs, fuse boxes, service terminals and patented metal wrappers for conduit joints. C. L. Bundy was in charge.

MOBILE ELECTRIC COMPANY, Newark, N. J., was represented by P. E. Ingalls and E. E. Whitehorne. Though but recently in the field as manufacturer of electric signs, the company had a large sign in nightly operation on the building of the Denver Gas & Electric Company opposite the hotel.

THE STANDARD PAINT COMPANY, of New York, distributed an attractive Russia leather mounted desk blotting pad, as well as some of the company's literature. Samples of Rubberoid roofing and its well-known P. & B. specialties were on exhibition. Messrs. Earnshaw and Beckman were in charge.

WESTERN ELECTRIC COMPANY, of New York and Chicago, had a very interesting exhibit consisting of its arc lamps, D. & W. fuses, Thomas high-tension insulators and Brookfield glass insulators. The company's interests were taken care of by E. W. Rockafellow, W. F. Hessel, A. L. Tucker and F. B. Killion.

CENTRAL ELECTRIC COMPANY, Chicago, distributed silver watch fobs with the association insignia $C = \frac{E}{R}$ on one side, and the name of the company and Okonite on the other. The company was represented by George A. McKinlock.

NATIONAL ELECTRIC LAMP COMPANY, of Cleveland, Ohio, was represented by J. R. Crouse, Jr., chairman of the advertising committee, who circulated a very interesting paper on central station advertising methods and the necessity of greater activity in pushing business by central station managers.

THE FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind., exhibited their new Wood prepayment watt-hour meters, which were fully described in our June number. The exhibit also included a multi-phase switchboard and meters, and was in charge of J. J. Wood, F. S. Hunting and A. A. Serva.

SANGAMO ELECTRICAL MANUFACTURING COMPANY, Springfield, Ill., had a working exhibit of its new types of watt-hour meters for direct current. R. C. Lanphier was in charge of the exhibit. One of the features of the display was an 800-ampere shunt, together with a properly calibrated meter for recording the entire energy of a system.

NATIONAL ELECTRIC COMPANY, Milwaukee, Wis., distributed one of the most acceptable souvenirs at the convention. This consisted of a watch fob made up of a heavy gold plated miniature field ring of the National alternating and direct-current machines, suspended from a heavy silk ribbon. The interests of the company were looked after by C. G. Burton.

THE PHELPS COMPANY, Detroit, Mich., displayed a variety of Hylo lamps, Wynk signs and Wynk transparencies. Skeedoole socket plugs, self-flashing lamps, Turn-up advertising lamps, and a new specialty known as the Skeedoodle A, connected in series with and flashing a number of lamps simultaneously, constituted a feature of this exhibit. W. E. Phelps and J. W. Phelps were in charge.

WAGNER ELECTRIC MFG. CO., of St. Louis, Mo., was represented by V. W. Bergenthal, Geo. B. Foster and G. P. Cole, who accompanied many of the delegates to the store of Gilbert, Wilkes & Co., the company's local representatives, where a large stock of single-phase motors, transformers and instruments was displayed. The company distributed a large number of bulletins at its convention headquarters on the same floor with the convention hall.

HENDRIE & BOLTHOFF MFG. & SUPPLY CO. had three large parlors and a staff of representatives at the convention. This company is the local representative of the National Electric Company, H. W. Johns-Manville Co., Stanley Electric Instrument Company, Stanley-G. I. Electric Mfg. Co., Century Electric Co., John A. Roebling's Sons Co., Electric Controller & Supply Co., Kuhlman Electric Co., and a number of engine and boiler manufacturers.

H. W. JOHNS-MANVILLE CO., of New York, had a very complete exhibit comprising a full line of National Electric Code standard fuses up to 600 amperes; fuse plugs, 1 to 30 amperes and 31 to 60 amperes; double and single brass blocks, and two and three-pole main line blocks. It also displayed a full line of Noark standard fuses, blocks and fuses, front and rear connection contacts, two and three-pole service cut-out boxes, and main-line single and double-branch subway boxes. The exhibit also included a representative line of molded overhead line material, molded mica weather-proof sockets, high tension strain insulators of a working pressure up to and including 5,000 volts. The exhibit was in charge of J. M. Perry and J. W. Hardy.

THE GENERAL ELECTRIC COMPANY had a large parlor adjacent to the convention hall. This was attractively furnished and decorated. The mercury arc rectifier exhibited by the company naturally called forth large interest. As a souvenir the company distributed a neat miniature frosted incandescent lamp mounted as a scarf pin. At Colorado Springs the company had for its headquarters the sun parlor at The Antlers. A list of the G. E. men present follows: General Irving Hale, manager Denver office; G. A. Woolley, supply manager Denver office; H. C. Glaze, sales department; C. P. Mahaffey, engineer, Denver office; J. V. Swanson, construction department, Denver office; Robt. Tait, auditor, Denver office; E. E. Gilbert, lighting department, Schenectady; A. D. Babson, supply manager, New York; M. D. Grosh, Salt Lake City; O. E. Turner, Dallas, Tex.; J. Scribner, lighting department, Chicago; W. F. Smith, Minneapolis; J. H. Livsey, Detroit; P. D. Wagoner, Schenectady; H. W. Hillman, Schenectady; F. G. Vaughn, Schenectady; H. J. Buddy, Philadelphia; F. H. Gale, advertising department, Schenectady; F. W. Wilcox, incandescent lamp department, Harrison, N. J.; C. B. Burleigh, Boston; H. C. Houck, Cincinnati.

WESTINGHOUSE ELECTRIC & MFG. Co. had an exhibit adjoining the convention hall which was unusually attractive. In the center of the room on a pedestal surrounded by palms was a cub bear holding in its right paw a Sawyer-Man incandescent lamp, and suspended immediately over the bear was a large eagle holding in its claws two of the "lumino" lamps of the Sawyer-Man Company. The display proper consisted of a full line of incandescent and arc lamps, lightning arresters, transformers, meters, circuit-breakers, motors, etc. The company had its headquarters in an adjoining room, where refreshments were served and literature descriptive of the company's apparatus distributed. A sign one hundred feet long and extending to within 20 feet of the ground floor was suspended from the roof of the lobby on which was spelled from top to bottom the name of the company. This sign was visible from every point inside the hotel, making a very attractive advertisement. The Nernst Lamp Company had on exhibit a full line of its lamps at the Hotel Savoy, E. R. Roberts being in charge. The representatives of the Westinghouse Company were taken out on a special car and consisted of the following: From the Westinghouse Electric & Manufacturing Company—C. S. Cook, manager of the railway and lighting department; C. B. Humphrey, manager detail and supply department; G. B. Griffin, manager of the same department; H. P. Davis, assistant chief engineer; W. C. Webster, assistant to the second vice-president; T. H. Bailey Whipple, general lamp agent; P. N. Jones, manager Denver district office; C. E. Skinner, Paul McGahan, K. C. Randal and Clarence Renshaw, engineers; S. A. Chase, of the New York sales office; W. R. Pinckard, of the Chicago district office; H. S. Sands, E. C. Means and B. S. Manuel, of the Denver district office. From Sawyer-Man Electric Company, Walter Cary, manager. From the Nernst Lamp Company—Max Harris, sales manager; S. Solomon and Mr. R. D. Marthens, district managers; E. R. Roberts, of the Pittsburg office. The Westinghouse Machine Company was represented by C. C. Chappell, manager of the Denver office. The arrangements were in charge of J. C. McQuiston, superintendent of the publishing department, and L. M. Cargo, the manager of the Denver office of the Westinghouse Electric & Manufacturing Company.

ALLIS-CHALMERS COMPANY was well represented at the convention by the following eleven officials: O. A. Stranahan, manager power department, Milwaukee; M. C. Miller, executive department, Milwaukee; C. A. Tupper, publicity department, Milwaukee; J. R. Jeffrey, assistant secretary Bullock Electric Manufacturing Company, Cincinnati, Ohio; David Hall, assistant chief electrical engineer, Cincinnati; Louis E. Bogen, engeer electrical department, Cincinati; George H. Berg, district office manager, Boston; George B. Foster, district office manager, Chicago; R. B. McConney, district office manager, Denver; H. L. Woolfenden, electrical department, Denver; R. J. Glendenning, assistant district office manager, Salt Lake, Utah. A large reception room was elaborately furnished and the walls hung with framed pictures representing Bullock electrical apparatus and leading installations. The bulletins elaborating on these themes covered two large tables. The new binders of the company, which are arranged so as to permit the bulletins inserted to lie perfectly flat when the binder is open, attracted much attention. Guests were taken from the door of the hotel in conveyances to the plant of the Denver Gas & Electric Company, where Allis-Chalmers engines and the following Bullock apparatus are installed: Two 1500-kw., three-phase, 60-cycle, direct-connected Bullock alternators; four 600-kw., three-phase Bullock belted alternators; two 400-kw. Bullock direct-current belted generators. This plant is the largest between the Missouri River and the Pacific Coast, and is a model of its kind.

Other companies not exhibiting but represented were as follows: Atlantic Insulated Wire & Cable Company, New York, George F. Porter, sales manager. Ko Sign Company, Denver, Charles F. Heywood, manager. American Steel & Wire Company, Chicago, H. J. Woelke, E. R. Poole, W. E. Benedict, Denver. Benjamin Electric Manufacturing Company Chicago, R. B. Benjamin, manager. John A. Roebling's Sons Co., E. B. Bartlett, Chicago. Pawling & Harnischfeger, Milwaukee, W. E. Kreamer. Electric Storage Battery Company, G. H. Atkin, Chicago manager, and T. B. Entz, St. Louis. De La Vergne Machine Company, New York, C. E. Lucke. Arnold Company, Chicago, W. Arnold. American Circular Loom Company, Chelsea, Mass., Thomas G. Grier, Western manager, Chicago. New York & Ohio Company, Warren, Ohio, W. D. Packard, manager. Western Chemical Manufacturing Company, Denver, L. B. Skinner. Electrical Testing Laboratories, New York, W. S. Howell, manager. Phoenix Glass Company, New York, A. H. Patterson, vice-president and manager; E. H. Fox, Chicago. Okonite Company, New York, George T. Manson, superintendent. Baker & Co., Inc., New York City, C. O. Baker, president. Chase-Shawmut Company, Newburyport, Mass., George A. Gray, India Rubber & Gutta Percha Insulating Company, New York, J. B. Olson, manager sales department. Western Lumber & Pole Company, Denver, B. F. Vreeland, president. American District Steam Company, Lockport, N. Y., C. R. Bishop, secretary and manager; H. C. Eddy, Western manager, Chicago. Chicago Fuse Wire & Manufacturing Company, Chicago, W. W. Merrill, manager. Otis Elevator Company, J. F. Elam, Denver. Bryan-Marsh Company, S. E. Doane, Cleveland; L. E. Mason, Denver. Standard Underground Cable Company, Pittsburg, J. R. Wiley, manager Chicago office, E. J. Pietzcker, Southwestern manager, St. Louis. Pass & Seymour, Solvay, N. Y., John W. Brooks, manager; J. S. Jackson, Chicago. Stanley-G. I. Electric Manufacturing Company, Pittsfield, Mass., Martin J. Insull, third vice-president; Thomas F. Clohesey, sales manager, St. Louis. Capital Electric Co., Denver, A. R. Hall, president. Jeffrey Manufacturing Company, Columbus, Ohio, F. R. Field, Western sales manager. Flint Lomax Manufacturing Company, Denver, F. W. Lomax, manager.

OBITUARY.

C. H. WELLMAN and T. R. MORGAN, both of the Wellman-Seaver-Morgan Company, were killed by the wreck of the Twentieth Century Limited train, June 21, at Mentor, Ohio.

WILLIAM W. DONALDSON, the well-known engineer of the Gould Storage Battery Company, died at Elk Ridge, Md., June 12, aged 42 years. Mr. Donaldson received his education at the well-known Carey School, Baltimore, and Princeton University. He engaged in storage battery work in 1884 and was connected successively with the Storage Battery Company, of Baltimore, the Eastern Electric Company, the Donaldson-Macree Storage Battery Company and the Gould Storage Battery Company.

FRANKLIN LEONARD WAINWRIGHT POPE, son of the late Franklin L. Pope, and nephew of Ralph W. Pope, secretary of the American Institute of Electrical Engineers, died at Cornwall, N. Y., May 27. Mr. Pope was born in Elizabeth, N. J., in 1880, and graduated from Amherst College in 1903. He was on the staff of the Assistant Signal Engineers of the Pennsylvania Railroad, but failing health compelled him to resign in September, 1904. He spent the winter at Saranac Lake, but the change was not beneficial. He was greatly interested in railroad work, and gave every promise of a brilliant future.

E. A. LESLIE, general manager of the Kings County Electric Light & Power Company, Brooklyn, N. Y., died on June 5 from pneumonia. Mr. Leslie was one of the large number of telegraphers who graduated from that branch of electrical work into electric light and power work in the eighties. He entered the telegraph service as a messenger boy and worked up through the various grades to the superintendency of the Mutual Union Telegraph Company, with headquarters at Washington, D. C., in 1882. In 1884 he was appointed superintendent of the National Telegraph Company, which was part of the Baltimore & Ohio system, and in 1885 he was made general superintendent of the Eastern Division with headquarters in New York. In 1888 he accepted the management of the Manhattan Electric Light Company's affairs. This company was afterward consolidated with the Edison Electric Company, with which he remained until 1901, when he became general manager of the Kings County Company. Mr. Leslie was born in Harrisburg, Pa., in 1849. He leaves a widow and two children.

PERSONAL.

MR. CHAS. S. DAVIS, for the past six years master electrician of the Bureau of Construction and Repair, Charlestown Navy Yard, has joined the engineering staff of the Holtzer-Cabot Electric Company, Boston, Mass.

MR. EUGENE LENTILHON, for several years past a contracting engineer in New York, has joined the forces of J. G. White & Company, Inc., and is now on his way to Chili on an important engineering mission.

MR. ALFRED WATERS PROCTOR has joined the staff of Rosenbaum & Stockbridge, the well-known New York patent attorneys. Mr. Proctor is an electrical engineer, and for the past seven years has been an examiner in the United States Patent Office.

MESSRS. EDWARD S. BEACH and CHARLES McC. CHAPIN have formed a partnership under the style of Beach & Chapman and have engaged in the practice of patent, trademark and copyright law. The new firm has established offices at 60 Wall Street, New York, and 53 State Street, Boston.

MR. W. W. FREEMAN has been appointed vice-president and general manager of the Kings County Electric Light & Power and the Edison Electric Illuminating Companies, of Brooklyn, to succeed the late E. A. Leslie, whose death is noted elsewhere. Mr. Freeman has risen step by step from the position of stenographer to the general manager in 1889 to his present responsible post.

Mr. HAROLD ULMER WALLACE has accepted the position of third vice-president of J. G. White & Company, Inc., resigning the position of chief engineer of the Illinois Central Railroad in order to affiliate with the White organization. Mr. Wallace will have charge of the company's construction department, and his headquarters will be at the main office in New York.

MR. W. S. HEGER, whose name has been closely associated for years with the Westinghouse interests, has joined the Allis-Chalmers Company, becoming assistant to the vice-president and general manager.

Born in 1857 at Fort Simcoe, Washington Territory, then one of the frontier posts of the United States Army, Mr. Heger received his education both in this country and Europe, spending seven years in Vienna, Austria. After receiving the degree of M.E. at Stevens Institute of Technology in 1879, Mr. Heger's business career began in the mechanical draughting room of the Edge Moor Iron Works. Shortly after this time the Edge Moor Iron Works took the contract for the construction of the Brooklyn Bridge. Mr. Heger was placed in charge of putting this work through the draughting room, through the shops and through the testing and inspection departments.

In 1885 Mr. Heger went into business upon his own account as a contractor and electrical engineer and later became sales agent and constructor for the Edison Company for isolated lighting in the states of Delaware, Maryland, the Virginias and the Carolinas. In 1889 Mr. Heger was sent to San Francisco as district manager for the Pacific Coast territory for the Edison Company and for the Edison United Manufacturing Company.

W. S. HEGER.

He built up the organization there which exists today under the General Electric Company, and established a large and successful business.

Owing to the serious illness of a daughter Mr. Heger gave up all business in the fall of 1890 and remained in retirement for two years. Resuming active work in 1902 he accepted the place of general manager of the Wilmington City Railway Company, Wilmington, Delaware, and spent three years there rebuilding and operating the road. Returning to the Pacific Coast again in 1895, Mr. Heger became the district manager for the Westinghouse Electric & Mfg. Company, with headquarters in San Francisco. He built up a strong selling organization and made a wide market for the products of his own company and those of the Sawyer-Man Company. At the beginning his territory covered the whole coast country from Alaska to Old Mexico, and reached east as far as Salt Lake City. As business was developed the territory was divided and district offices were opened at Seattle, Salt Lake City, Los Angeles and in British Columbia. Mr. Heger's work was marked particularly by his success in inventing methods to promote and secure sales in sparsely settled districts, and in securing the co-operation of affiliated lines of business.

During Mr. Heger's administration the initial long distance power transmission plants of the Pacific Coast were built, and in the construction of these many unlooked-for features had to met. The creating of a market for the products of his company in the new fields developed by these long distance transmission plants formed a valuable part of his experience.

Mr. Heger resigned his position with the Westinghouse Company in April. His headquarters are at the general offices of the Allis-Chalmers Company in Milwaukee.

TRADE PUBLICATIONS.

SWITCHBOARDS. The Switchboard Equipment Company, Pittsburg, Pa.—Bulletins Nos. 2 and 3, devoted to circuit-breakers and motor control panels.

TWO-PLATE STORAGE BATTERY. The Electric Storage Battery Company, Philadelphia, Pa.—Bulletin No. 92, in which is described and illustrated the two-plate Chloride cell.

AN ELECTRIFIED RAILWAY SHOP. Crocker-Wheeler Company, Ampere, N. J.—This is bulletin No. 58, containing an illustrated description of the motor equipment of the Pittsburg & Lake Erie Railroad shops.

THE IDEAL ENGINE. A. L. Ide & Sons, Springfield, Ill.—A vest-pocket pamphlet handsomely executed and containing a well-illustrated argument in favor of the Ideal automatic engine for electric light and power service.

WATER-TUBE BOILERS. Parker Boiler Company, Philadelphia, Pa.—This is the 1905 catalogue of this company and contains an illustrated description of its well-known water-tube boiler, with and without superheater attachment

VARIABLE-SPEED MOTORS. The Electro-Dynamic Company, Bayonne, N. J.—Circulars Nos. 13 and 14, the one devoted to individual motor-drive and the other to a description of the "Interpole" variable-speed motor.

STEAM SPECIALTIES. The Loew Supply & Manufacturing Company, Cleveland, O.—A handsome catalogue of octavo size devoted to Loew grease and oil separators, feed-water heaters, steam separators, exhaust heads, condensers, etc.

MERCURY ARC RECTIFIER. General Electric Company.—This is bulletin No. 4411, containing an illustrated description of the G. E. mercury vapor tube and accessories for obtaining direct current from an alternating-current circuit.

WATER - WHEEL GOVERNORS. Replogle Governor Works, Akron, O.—This is a catalogue of standard size devoted to the new Replogle water-wheel governor, which was described in connection with the water-wheel article in our January number.

EMPLOYERS' LIABILITY. The Consolidated Engine Stop Company, New York.—This is a folder containing extracts from the opinion rendered by the Court in a recent damage suit on which occasion favorable comment was made of the Monarch engine stop.

OIL SWITCHES AND CIRCUIT-BREAKERS. Hartman Circuit-Breaker Company, Mansfield, O. —Bulletin No. 6, devoted to the well-known Hartman switches and circuit-breakers, representative types of which were recently described in this paper.

LIFTING MAGNETS. The Electric Controller & Supply Company, Cleveland, O.—This is a handsomely executed catalogue of standard size, containing illustrations of electromagnets for lifting pig iron, sheet and wire scrap, large castings, etc.

STEAM CONDENSING APPARATUS. W. H. Blake Steam Pump Company, Hyde Park, Mass.—This is catalogue No. 25, containing illustrations and brief descriptions of the Blake horizontal air pump and jet condenser, witn vertical air pump and jet condenser, and surface condenser with air and circulating pump.

ORE AND COAL-HANDLING MACHINERY. The Wellman-Seaver-Morgan Company, Cleveland, O.—This is a magnificent publication of octavo size, profusely illustrated and handsomely executed. As its title indicates, it is devoted to machinery of all types for handling coal and ores.

OIL-INSULATED TRANSFORMERS. Stanley-G. I. Electric Manufacturing Company, Pittsfield, Mass.—This is bulletin No. 145, containing an illustrated description of the "Type B. O." oil-insulated transformers for lighting service. These are built in all of the standard voltages, of course, and are of the shell type.

ELECTRIC LIGHT SPECIALTIES. The Tea Tray Company, Newark, N. J.—Catalogue No. 15, of convenient pocket size, devoted to lighting specialties such as incandescent lamp hoods, street fixtures for incandescent lamps, goose-neck brackets and flanges, weatherproof sockets, shades and reflectors for indoor lamps, etc.

BELTED ROTATING FIELD ALTERNATORS. Westinghouse Electric & Manufacturing Company.—This is circular No. 1113, containing an illustrated description of a very compact type of revolving-field alternator. The bearings of the machine are mounted in circular brackets similar to those of the familiar self-contained induction motor.

MAP OF THE N. Y. SUBWAY SYSTEM. New York Central & Hudson River Railroad.—This is No. 39 of the Four-Track Series, and consists of a very clear, well-executed map of the subway and elevated railway systems on Manhattan Island and in the Bronx, showing the connections between the railway systems and the New York Central Railroad.

THE CARE OF INSULATING COMPOUNDS. Sterling Varnish Company, Pittsburg, Pa.—An extremely valuable and instructive book of pocket-size, containing much practical information relating to the application, testing and care of insulating compounds and varnshes. The contents of the book are devoted chiefly to Sterling compounds, of course, but it is nevertheless valuable to users and repairers of electrical machinery.

BUSINESS NEWS.

TIPLESS LAMP COMPANY, New York, has removed its general offices and show rooms to 256 West 23d street.

MANUFACTURERS AGENTS' ASSOCIATION, Los Angeles, Cal., has removed its main offices from 308 South Los Angeles Street to 641 Huntington Building.

WESTERN ELECTRIC COMPANY, Chicago and New York, reports a brisk trade in Sunbeam incandescent lamps, the sales being unusually large for this season of the year.

THE NEW YORK COIL COMPANY, New York, recently filled an order for induction coils to equip six wireless telegraph stations in South America.

PITTSBURG GAGE & SUPPLY COMPANY, Pittsburg, Pa., reports a large number of recent sales of "White Star" oil filters, many of which were for electric light and power service.

CRANE COMPANY, Chicago, has removed its general offices and sales department from 10 North Jefferson Street to its new office building at 519 South Canal Street.

STANLEY INSTRUMENT COMPANY, Great Barrington, Mass., announces that it is now prepared to fill all orders for model H-6 jewel-bearing wattmeters, which are of the induction type.

THE LOCKE INSULATOR MANUFACTURING COMPANY, Victor, N. Y., has started still another addition to its factory since the one recently noted. The new addition will cover a ground space 40 feet by 100 feet, and will be devoted exclusively to the process of cementing together the parts of the multi-part porcelain insulators.

AITON MACHINE COMPANY, New York, has been incorporated under the laws of New Jersey for the manufacture and sale of machinery covered by the patents of Thomas A. Aiton relating to wire insulating, cabling and rubber manipulating machinery. The company's manufacturing operations will be carried on in conjunction with the work of the Marine Engine & Machine Company, Harrison, N. J.

ALLIS-CHALMERS COMPANY, Chicago, reports among a large number of recent sales one to the Twin City Rapid Transit Company, Minneapolis, of a vertical, cross-compound Reynolds-Corliss condensing engine to be direct-connected to a 3500-kw., three-phase alternator. This is the fourth engine of this size and type ordered from the Allis-Chalmers Company by the Twin City Company.

CENTURY ELECTRIC COMPANY, St. Louis, Mo., reports that its single-phase, alternating-current motors are steadily increasing in popularity as the trade becomes familiar with the inherent features of the machine. During the month of May alone the company's sales of single-phase, self-starting motors exceeded its entire sales for the year of 1904. These machines are built in sizes ranging from ½ to 5 horse-power, for 60 cycles and other commercial frequencies.

THE C. & C. ELECTRIC COMPANY, Garwood, N. J., reports having taken a number of orders recently for direct-connected motors for driving machine tools. Among others is one from the Pittsburg office for some twenty motors, nearly all of which are of the variable speed type.

G. M. GEST, of New York and Cincinnati, has just been awarded the contract for the construction of a complete underground conduit system for the Montreal Light, Heat & Power Company, Montreal, Canada. Over 1,000,000 feet of conduit are to be used in the construction.

INGERSOLL-RAND COMPANY is the title of a new corporation which is an amalgamation of the Ingersoll-Sergeant Drill Company and the Rand Drill Company. The new organization has been incorporated under the laws of New Jersey, with a capitalization of $10,000,000. The factories are located at New York, Painted Post, N. Y., Ossining, N. Y.; Tarrytown, N. Y.; Phillipsburg, N. J.; Easton, Pa., and Sherbrooke, Quebec. The main offices of the new company will be located for the present at 26 Cortlandt Street, New York.

THE PEERLESS ELECTRIC COMPANY, Warren, Ohio, is unusually busy at this season, finding it necessary to operate the factory day and night, and reports a fine lot of orders booked. In the fan-motor department, the output on regular lines is largely increased, and the new type of oscillating fan is being well received by the trade. A special high voltage testing transformer has just been furnished to the Jefferson Physical Laboratory of Harvard University, a duplicate of the transformer recently supplied to the laboratory of Johns Hopkins University. Contracts on hand ensure weeks of steady operation in the motor department, and new machinery is being added to care for the growth of this branch of the business. Among large jobs just installed are the complete equipment with individual motors of the extensive planing mills of the Warren Manufacturing Company and the Western Reserve Lumber Company, both at Warren.

THE WESTINGHOUSE ELECTRIC & MFG. COMPANY has just closed a contract for the equipment of the main generating station and four rotary converter sub-stations of the Cincinnati Northern Traction Company. The power house will be located at Hamilton, Ohio, and the original installation will be of 5,000 kilowatts capacity, with provisions for ultimately increasing it to 10,000 kilowatts. In the generating station will be located three 1500-kw. and one 500-kw. three-phase, turbine-type generators, and three 300-kw. rotary converters. Current will be generated at 375 volts to avoid the necessity of lowering transformers for the main station rotaries. The outgoing lines will be required with raising transformers having a ratio of 375 to 33,000 volts. Each generator will be driven by a Westinghouse-Parsons steam turbine and excited by a direct-current generator attached to the end of the turbine shaft. Each sub-station will contain a 300-kw. rotary converter supplied by three 33,000 to 375-volt step-down transformers. All transformers are of the oil-insulated, self-cooling type. Besides the above, the contract includes all necessary switchboards and protective devices for the control and protection of apparatus in the power house and rotary stations.

CENTRAL STATION NEWS

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

ALABAMA.

ENSLEY.—The Mayor and Board of Aldermen are stated to have authorized the Lighting Committee to investigate the question of constructing an electric light plant, procure plans and specifications and report back to Council July 6.

GADSDEN.—Plans are on foot for the building of a power plant on Little River, near Gadsden, to cost between $1,000,000 and $1,500,000, to furnish power to many nearby towns and cities. H. T. Henderson and brother, of Durango, Col., are interested.

TALLADEGA.—Power has been turned on from the new plant at the shoals on Chocolocco Creek. The city will, in the future, be lighted from this plant, and power furnished manufactories. Engineers estimate that 5000 horse-power is available from this point.

FLORENCE.—Articles of incorporation of the Mussel Shoals Power Company have been filed with the office of the Probate Judge of Colbert County, at Tuscumbia. The officers of the company are Thomas H. Jackson, of Memphis, president; James Jackson, of Tuscumbia, vice-president, and John H. Harris, of Courtland, secretary and treasurer.

ARIZONA.

WINSLOW.—At a recent special election the people voted in favor of granting a franchise for electric light and power purposes to the Winslow Electric Light & Power Company.

PRESCOTT.—The Arizona Power Company has been organized for the purpose of supplying electrical power within the bounds of Yavapai County, commercially, and at a cost that will make it an inducement for mines or any other business institution that will require power to use its product. The company now has privileges for the development of power on Fossil Creek, about 25 miles east of Mayer.

ARKANSAS.

PRAIRIE GROVE.—An electric light plant is soon to be established in this city.

FORT SMITH.—Bonds have been sold to the amount of $17,000 for the purpose of installing an electric light plant in Durdanelle.

WARREN.—The Warren Light & Water Company is reported incorporated with a capital of $12,000, to construct an electric light and power plant. Fred. L. Purcell, president; Carl Hollis, secretary.

ROGERS.—The Rogers Light & Water Company, of this city, has been incorporated with a capital stock of $100,000. Officers are W. R. Felker, president; F. F. Freedman, vice-president; J. E. Felker, secretary and treasurer.

CALIFORNIA.

WHITTIER.—The Edison Electric Company will double the capacity of its plant.

TRUCKEE.—The plant of the Truckee Electric Light & Power Company is reported to have been destroyed by fire.

SEBASTOPOL.—The Sebastopol Light, Power & Water Company has secured the franchise for the electric light and power plant.

SANTA ANA.—It is stated that bids will be received until July 3 by Edward Telford, City Clerk, for $57,000 electric light and power bonds.

SIERRAVILLE.—The Sierra Valley Light & Power Company has begun digging a big ditch which will connect with the flume feeding its power plant. The ditch will be two miles long.

VENTURA.—C. E. Moore, of Santa Clara, is reported to have been selected to prepare plans and estimates for water works and an electric light plant for Ventura.

IONE.—The Ione Electric Light & Power Company is reported incorporated, with a capital of $30,000, by Chas. Erickson, John Hancock and others.

FORT BRAGG.—It is reported that the Fort Bragg Electric Light Company, Inc., has applied for a franchise to construct and operate an electric plant for generating electricity to furnish heat, light and power for this city.

UKIAH.—It is reported that a franchise has been applied for by A. Brown for the right of way, erection of poles, etc., for the transmission of electricity for power, etc., over roads between Elk and Gualala, and bids for said franchise will be received until July 3.

FRESNO.—The San Joaquin Light & Power Company is reported incorporated with a capital of $3,000,000, by H. W. O'Melveny, of Los Angeles; Abraham Haas, of San Francisco, and others. It has taken over the plant of the San Joaquin Power Company at Fresno and proposes developing the water power of San Joaquin River and supplying Fresno and surrounding territory with light and power.

SAN FRANCISCO, CAL.—President H. L. Shannon says that the Shasta Power Company has a force of 75 men at work at its power site, near Bear Creek Falls, Shasta County, 24 miles east of Redding. All materials will be delivered promptly, and it is expected that the first unit of 1500 horse-power will be installed in September next. The plant is in the center of the great copper belt mining and smelting region.

SAN FRANCISCO.—The Washoe Power & Development Company's water power electric plant, located ten miles east of Reno, Nev., is in operation, transmitting to Reno and to Sparks, 12 miles. A distributing system has been installed for light and power purposes. The initial installation includes a Stanley 750 kw., three-phase generator, direct connected to a water wheel. Specifications have been issued for an additional 750-kw., three-phase generator for the same plant.

SAN FRANCISCO.—Sidney Sprout, general manager of the Culiacan Electric Company, a San Francisco corporation, has returned from Culiacan, Mexico, where he was making arrangements for the installation of the first unit of the new lighting plant. This will carry the street lighting, for which a contract has been closed. Babcock & Wilcox boilers, and Ideal engine and a General Electric 100-kw., three-phase generator will be shipped within a few weeks by steamer from San Francisco, and the entire system will be in operation by September 1. Negotiations have been in progress for the purchase of the small electric plant now in operation on commercial lighting.

SAN FRANCISCO.—At a special meeting of the stockholders of the Battle Creek Power Company, held June 5, it was voted to authorize an issue of 30-year bonds amounting to $1,000,000 for the purpose of carrying out the project of constructing an electric power transmission in Butte County, Cal. The company's complete plans are not ready for publication, but it is understood that the gold-dredging districts, including Oroville, are expected to furnish a market for a part of the electric power to be developed by a modern hydro-electric plant. Dudley C. Bates is secretary of the company. Several electric railways which are projected in the same territory may be purchasers of power in time.

SAN FRANCISCO.—The Oceanside Electric Light Company, which has been incorporated with a capital stock of $20,000 by R. H. Fitzgerald, J. T. Boyd, H. B. Young, J. H. Brenner and J. D. McGown, will erect an electric generating plant near the ocean beach in San Francisco. It is said that many contracts have been signed for lighting current for terms of three years at 10 cents per kw.-hour. R. H. Fitzgerald is president of the

company; J. H. Brenner, secretary, and J. T. Boyd, general manager. The ocean beach district extending several miles south of the Cliff House, is building up rapidly, and the nearest lighting plant is six miles distant. It is said that Los Angeles capital is behind the new enterprise.

COLORADO.

DENVER.—It is proposed to build a subway on, probably, Sixteenth Street, in this city, and place the overhead wires therein.

NEW CASTLE.—The Henry Electrical Corporation, of Denver, has purchased the Peter Kinney electric light plant of this city and is overhauling the plant and remodeling it along more improved lines. New machinery throughout will be installed.

CONNECTICUT.

SHARON.—The Sharon Electric Light Company has received permission to operate in Canaan and North Canaan.

WALLINGFORD.—A resolution has been offered for the purpose of extending and enlarging the electric plant of the borough and utilizing the water power of the Quinnipiac River in the manufacture of electricity.

HARTFORD.—The Committee on Incorporations reported favorably on the resolution incorporating the Northern Connecticut Power Corporation. This corporation will acquire the water privileges in New Hartford known as the Greenwood water power.

NORWICH.—The committee on incorporation of the Legislature has reported favorably the petition for a charter for the Uncas Power Company, of Norwich. The charter gives the company the right to manufacture and distribute electricity in the towns of Bozrah, Colchester, East Lyme, Franklin, Griswold, Groton, Lebanon, Ledyard, Lisbon, Lyme, Montville, North Stonington Old Lyme, Preston, Salem, Sprague, Stonington, Voluntown and Waterford, and in Norwich and New London in quantities of not less than 25 horse-power to any single customer. The promoters are G. O. Jackson, E. W. Higgins and Charles W. Comstock.

NORWICH.—At a recent meeting of the City Council it was voted to give to the Gas and Electric Commissioners the sum of $60,000, to be expended on repairs to the old plant and to make extensions for new business. The commissioners intend to build a new water gas plant, a new condenser plant, including scrubbers, exhausters, tar and ammonia extractors, and new purifiers. About two miles of new mains will be laid. For the electric plant there will be a new 24-kw. unit direct connected, and a new stack. The city will also have 80 additional incandescent street lights of 25 candle-power for the new district called East Norwich. Extensive repairs will be made on the lines.

DELAWARE.

WILMINGTON.—Mayor Bird has suggested to the Water Commissioners the advisability of constructing an electric light plant to light the reservoirs and park lands and eventually for lighting the city.

WYOMING.—Alex. Daly, representing Philadelphia capitalists, is reported to have presented to the citizens of Wyoming and Camden a proposition to install a water and light plant to supply both towns.

DISTRICT OF COLUMBIA.

WASHINGTON.—The Potomac Electric Power Company has secured the contract for arc lights in certain public parks at $85 per light per year, or a total of $5525.

FLORIDA.

ST. AUGUSTINE.—Gen. Foster is reported to have petitioned Council for a franchise for an electric light plant.

TARPON SPRINGS.—L. R. Fernald, City Clerk, writes that it is proposed to construct an electric light plant and ice factory, at a cost of $6000.

OCALA.—The Florida Power Company is reported incorporated with a capital of $300,000 by W. N. Camp, R. F. Brewer, G. D. Munsing and others.

ST. AUGUSTINE.—J. D. Lawrence, of Jacksonville, is reported interested in the construction of an electric light plant and street railway in St. Augustine.

MONTICELLO.—The Monticello Power Company has been incorporated with a capital of $10,000, to own and operate an electric light and power plant. Incorporators: John M. Henry, John M. Hay, Jr., and S. M. Coat.

GEORGIA.

TALLAPOOSA.—The citizens are reported to have voted to grant Gelder & Black a franchise for an electric light plant.

FORT VALLEY.—Bond to the amount of $12,000 are reported sold, to be used for the construction of an electric light plant.

MONTICELLO.—The citizens are reported to have voted to issue $30,000 bonds for an electric light plant, water works and sewerage system.

MENLO.—The proposed power plant to be constructed near Menlo will cost $150,000. A. J. Lawrence, of Chelsea, Ga., is interested.

SAVANNAH.—A $50,000 subway has been completed in Savannah by the Savannah Electric Company, the Atlantic Coast Line and the city.

SAVANNAH.—The Savannah Lighting Company is in the field for the franchise for municipal lighting against the Savannah Electric Company, which now has possession of the field and franchise.

COLUMBUS.—Press reports state that the Westinghouse Electric & Manufacturing Company, of New York, N. Y., is preparing plans, specifications and estimates for the construction and equipment of the Chattahoochie electric plant for Stone & Webster, of Boston, Mass.

CARTERSVILLE.—The Etowah Power Company, of Gainesville, is reported to have purchased the property of the Etowah Development Company, with privilege to develop and control the water power of Etowah River. It is stated that a survey of the property will be made at once. Engineer, W. A. Carlisle, of Gainesville.

IDAHO.

RATHDRUM.—Nixon & Kimmel have been granted a franchise and will put in a lighting system, under the name of Rathdrum Electric Lighting Company.

COVE.—The power plant being installed in this city is nearly completed and is expected to be furnishing energy for electric lights in the Grande Ronde country by July 1.

HAILEY.—The Cramer Electric Company is stated to have decided to purchase the plant of the Idaho Electric Supply Company, and will furnish light for Hailey and Bellevue. A new plant will probably be installed.

ILLINOIS.

NOKAMIS.—The Henry Electric Light & Power Company, of Nokomis, is reported incorporated with a capital of $20,000 by John H. Crickenberger, Fred. W. Potter and Chas. A. Onyum.

STREATOR.—The Council is reported to have appropriated $30,000 for the establishment of a municipal lighting plant.

PANA.—The Pana Gas & Electric Company is reported incorporated, by T. F. Russell, Wm. Pierce and others, to manufacture electricity for light, heat and power.

PANA.—The National Power, Light & Heating Company is reported organized, with J. N. C. Shumway, of Taylorville, president, and Geo. B. Martin, of New York, N. Y., secretary.

MACOMB.—The Macomb Electric Light & Gas Company is installing new machinery and expects shortly to give all day and night service. The power and lighting circuits are three-phase, 60-cycle alternating current. W. I. Savidge is the electrical contractor.

BUSHNELL.—The City Council has granted a ten-year extension of franchise to the Bushnell Electric Light & Power Company, with a provision that certain additional equipment be added to the present plant within 90 days after July 1. Two 175 horse-power boilers, two 175 horse-power engines and generators, and auxiliary equipment will be purchased by the company at once.

INDIANA.

CRAWFORDSVILLE.—The Water & Light Company is reported to have decided to expend about $125,000 in improvements.

CONNERSVILLE.—It is reported that the Connersville Light, Heat & Power Company will expend about $25,000 in improvements.

CAYUGA.—The Town Board is reported to have ordered plans and will soon let contracts for constructing an electric light plant.

GREENFIELD.—The Water and Light Commissioners are reported to be in the market for a 350-h.p. engine and two new boilers for the electric light plant.

MONTPELIER.—The Montpelier Light & Water Company has been incorporated, with a capital of $75,000. The directors are T. J. Driscoll, P. C. Connors and others.

WASHINGTON.—The Town Trustees contemplate installing 150 enclosed arc lights to take the place of the open lights now in use. M. A. Roberts is superintendent.

FRANKFORT.—The Indiana Hydraulic Company is reported organized, with Eugene Rush, president, and N. W. Hanna, secretary, both of Frankfort. The company will be incorporated with a capital of $2,000,000 and will manufacture electricity. It will get its power from Wildcat Creek. A dam 30 ft. high and 368 ft. long, of solid cement, will be constructed.

ANDERSON.—A number of farmers living within a radius of six miles have petitioned the City Council to be connected with the municipal electric light plant. The city authorities look favorably on the request. The electric light plant has been enlarged and has a surplus of power which can be utilized in this way. The farmers have agreed to furnish the poles.

MONTICELLO.—The Tippecanoe Hydraulic Company is reported organized to utilize the water power of Tippecanoe River; capital, $800,000. It is proposed to construct four power plants, one at Norway, another at Tioga, another at Oakdale and the fourth at Springboro. Work is about to begin on the plant at Norway, which will cost about $195,000. The company proposes furnishing power to Lafayette, Logansport and Frankfort. A. A. McKain, of Indianapolis, and C. D. Meeker and D. W. Thompson, Jr., of Frankfort, are reported interested.

INDIAN TERRITORY.

WYNNEWOOD.—J. H. Boozer, City Recorder, writes that it is proposed to vote on issuing bonds for the construction of water works and an electric light plant, but nothing definite has been done, except to appoint a committee to figure cost, etc.

IOWA.

WAUKON.—The electric light company proposes to construct a concrete dam 200 ft. long and 20 ft. high.

ALDEN.—T. R. Holmes, City Clerk, writes that it was voted to grant an electric light franchise to the Paterson Heat, Light & Water Co.

OSCEOLA.—The Osceola Electric Light Company has been incorporated by the Osceola Light, Heat & Power Company.

CLARINDA.—Plans for remodeling and enlarging the building of the Lee Electric Light Company have been made.

SUMNER.—L. L. Stewart, of Omaha, is reported to have secured a franchise for an electric light plant.

VALLEY JUNCTION.—The Valley Junction Water & Light Company has been incorporated with a capital of $12,000. John Fisher is one of the incorporators.

COUNCIL BLUFFS.—Creston will have a new electric company. The organization was launched with an authorized capital of $50,000. Incorporators: J. C. Sullivan, John Hackett and others.

FORT DODGE.—The City Council is reported to have appointed a committee to investigate the construction of a gas and electric light plant, to be owned and operated by the city.

CRESTON.—The City Clerk writes that a franchise to run an electric light plant has been granted

to a new company, with J. C. Sullivan, president, and J. W. Reynolds, secretary. The company is now arranging to purchase equipment for a plant to cost about $40,000.

KANSAS.

WINFIELD.—The citizens have voted to issue $15,000 bonds to complete the electric light plant.

CHETOPA.—A. R. Bell, City Clerk, writes that the proposed water works and electric light plant will cost $29,500.

FRONTENAC.—The Crawford County Light & Water Company has secured a franchise for an electric light plant. H. G. Whiteleather is city clerk.

TOPEKA.—The Citizens' Light, Heat & Power Company is reported incorporated with a capital of $300,000 by J. J. Heim, of Kansas City; Arnold Kalman, of St. Paul, Minn.; Jas. L. Wolcott, of Dover, Del., and others.

LAWRENCE.—The Lawrence Electric Light Company has been reorganized, with Irving Hill as president and R. C. Johnston as secretary and manager. The company proposes to purchase new engines and dynamos and to enlarge the plant to three times its present capacity.

KENTUCKY.

PADUCAH.—The Paducah Gas & Electric Company has been sold to James C. Utterback. The price paid is stated to be $135,000.

GRAYSON.—Claude Wilson, of Olive Hill, has secured a franchise for an electric light plant and telephone system. The total cost of work will be about $25,000.

MORGANFIELD.—T. W. Gilbert, of Chicago, has purchased the electric light plant for $6,000. The new owner proposes to install a 3,000-light generator and a 200-h.p. engine.

PADUCAH.—Plans, specifications and estimates on contracts for the complete electrical construction and equipment for the new Paducah electric light and power plant to be built by St. Louis and New York capitalists are being prepared.

CAMPBELLSVILLE.—J. L. Atkinson, president Campbellsville Lighting Company, writes that bids for constructing an electric light plant to cost about $4000 will be received about Aug. 15. Engineer, B. S. Kincort, Lebanon, Ky.

GEORGETOWN. — The Georgetown Water, Gas, Electric Light & Power Company is reported reorganized, and will add a steam-heating plant and a new gas plant. F. X. Long, Newport, and S. L. Allen, Georgetown, are among the incorporators.

LOUISIANA.

ROBELINE.—A new electric plant will be established in this city soon.

NEW ORLEANS.—R. S. Stearns writes that the Algiers Railway & Lighting Company is to construct a power plant at a cost of $200,000.

BATON ROUGE.—It is reported that the Baton Rouge Gas & Electric Company will double the capacity of its plant.

NEW ORLEANS.—The Consumers' Electric Light Company has secured a site for its plant and will at once begin the erection of a first-class and completely equipped building.

BATON ROUGE.—The Baton Rouge Electric & Gas Company has acquired the Capital Light & Power Company. Mr. C. H. Kretz has become general manager.

SHREVEPORT.—W. R. Thomas, city secretary, writes that an election will be held in August to vote on issuing $150,000 bonds for the construction of a municipal electric light plant.

ABBEVILLE.—Bids will be received by the Board of Aldermen (Geo. W. Summers, secretary) July 3 for the purchase of $40,000 bonds, to be used for the construction of water works, sewerage system and electric light plant.

SHREVEPORT.—Mayor Querbes and the Lighting Committee are reported to have decided to recommend that Council enter into a contract with the Shreveport Gas, Electric Light & Power Company for lighting the city for a period of six years.

MAINE.

PITTSFIELD.—Patrons of the electric lighting service of the Sebasticook Power Company were put on the meter system on June 1. The company has notified the consumers that an established rate had been made.

AUBURN.—A contract for lighting the city's streets has been made by the Auburn city government with the Lewiston & Auburn Electric Light Company, the price being $18 a light more than the city is now paying. The company will spend about $5000 installing a new system and will give the city a better lighting service.

BANGOR.—Farson, Leach & Co., of New York, N. Y., are reported to have decided to finance and develop the property of the Bodwell Water Power Company, in Oldtown and Milford. The company will at once construct a concrete dam and an electric power plant to generate about 6,000 horse-power in addition to present development.

MARYLAND.

ELKTON.—B. F. Groff is stated to have purchased the mills and water power at Gilpins Falls, near Bayview, which will be developed for illuminating and manufacturing purposes.

ELLICOTT CITY.—Victor G. Bloede, of Baltimore, treasurer Patapsco Electric & Manufacturing Company, writes that it is proposed to construct a plant on Patapsco River, below Ellicott City, for the purpose of generating electric current for light and power. The approximate capacity of the power plant will be about 900 horse-power.

MASSACHUSETTS.

NANTUCKET.—A charter is reported to have been granted to the Citizens' Gas, Electric & Power Company, of Nantucket.

HAVERHILL.—The Haverhill Electric Company is to rebuild its plant on Water Street at a cost of $25,000.

GLENDALE.—The Monument Mills Company, of Housatonic, is reported to be making plans to develop the water power at Glendale.

SPRINGFIELD.—The Springfield Electric Company, of Springfield, is reported to have secured the contract for electric wiring the new technical high school, for $4700.

NATICK.—The Selectmen have granted the Edison Electric Illuminating Company, of Boston, a franchise for the purpose of running its high-current lines from the Dover line to its local power station.

BROCKTON.—The Gas Commissioners have refused to grant the petition of the Edison Electric Light Company, of Brockton, to issue $175,000 additional capital stock to take up $100,000 bonds and $75,000 notes.

WOBURN.—The Woburn City Council has passed over Mayor Reade's veto an order transferring the franchise of the Woburn Light, Heat & Power Company to the Edison Illuminating Company.

LYNN.—The Gas and Electric Light Commission has authorized the Lynn Gas & Electric Company to issue 2300 shares of new stock, at a value of $200 per share. Part of the proceeds is to be devoted to the payment of indebtedness and the balance to the plant.

BOSTON.—The Gas Commissioners have authorized the United Electric Light Company, of Springfield, to issue 2000 additional shares of capital stock at $260 per share; 820 shares will be used to take up notes and the remainder, 1180 shares, will be applied to additions to plant.

HOLYOKE.—Treasurer R. C. Winchester, of the Holyoke Water Power Company, has received permission from the River and Harbor Commission for the use of a part of the river bed for a site for the new electrical generating power plant. The force of engineers has begun preliminary work on the proposed site.

HOLYOKE.—Plans are reported to have been completed for the new power plant of the Holyoke Water Power Company on the west bank f Connecticut River. The plans call for the construction of a new canal, from which water will be conveyed to a power plant generating 7000 horse-power.

SOUTH FRAMINGHAM.—The Committee on Public Lighting has recommended that all street lights be discontinued July 1. At the annual town meeting $7500 was appropriated for public lighting. The Edison company, however, will not light the town, under the present schedule, short of $9000, nor will a shorter schedule be considered at a reduced price.

QUINCY.—The Massachusetts Electric Light and Gas Commissioners have given a hearing at the Quincy City Council chamber on the petition of Henry L. Kincaide and others of that city, asking for a reduction in the prices charged by the Quincy Electric Light & Power Company for electricity within the limits of that city. Chairman Barker stated the board would take the case under advisement, and in the meantime would compare the prices charged by the Quincy Company with those charged in other cities and towns.

MICHIGAN.

HUDSON.—The Hudson Electric Light Company has been formed with $25,000 capital.

JACKSON.—The directors of the Capital Light & Power Company are reported to have decided to expend about $8000 for new machinery.

REPUBLIC.—The citizens are reported to have voted to issue $20,000 bonds for water works and an electric light plant.

TRENTON.—The village electric light plant and water works are reported to have been destroyed by fire May 28. D. W. Peaume, chief engineer.

MONROE.—The Monroe City Council has apparently become sick of owning a municipal lighting plant. A proposition was made by City Surveyor White to lease the plant for ten years. The plant is for sale.

FORT BRADY.—Contracts have been awarded as follows for lighting Fort Brady: To the General Electric Company, for a supply of transformers, wattmeters and arc lamps, $1211; to W. L. Murdock, of Sault Ste. Marie, for interior and exterior work, $9513, and to the Edison Sault Electric Company, Sault Ste. Marie, for current (interior) at 6.6 cts. per kw.-hour and for exterior lighting $47.50 per arc light per year.

MUSKEGON.—A ten-year contract has been entered into between the Grand Rapids-Muskegon Water Power Electric Company and the directors of the Interurban Railway Company for furnishing power for the propulsion of interurban cars. The Water Power Company proposes to expend $100,000 for machinery for the power station which it proposes to build at the dam now being constructed across the Muskegon River, near Rogers' bridge, about six miles directly south of Grand Rapids.

MINNESOTA.

GIBBON.—This town is reported to be considering the construction of an electric light plant.

SOUTH ST. PAUL.—The City Council has granted A. Baumgarten, John Coats and others a franchise for an electric light plant to cost about $15,000.

MINNEAPOLIS.—Articles of incorporation have been filed with the Secretary of State by the Hughes Electric Company, of Minneapolis; capital stock, $100,000. Incorporators: Alexander H. Hughes, of Minneapolis; E. A. Hughes and W. V. Hughes, of Bismarck, N. D.

MISSISSIPPI.

GREENVILLE.—The Greenville Electric Light & Gas Company was purchased by the Delta Light & Power Company.

STARKVILLE.—Bonds to the amount of $8000 are reported sold, to be used for enlarging the water and light plant.

DURANT.—J. G. Hamilton, mayor, writes that it is proposed to replace the present electric light plant with a larger plant at a cost of $12,000, and bids for construction will be received about July 3.

LAUREL.—The Laurel Improvement Company is reported to have accepted the franchise offered by the city and will begin at once the construction of a light and power plant, at a cost of $25,000.

MISSOURI.

MARSHALL.—The Marshall Light, Heat & Power Company, of New York, has filed articles to show that it has been incorporated under the laws of the State, with a capital stock of $150,000, all of which is to be employed in Missouri. The company's office will be in Marshall.

ST. CHARLES.—The St. Charles Lighting Company was incorporated May 31 with a capital of $100,000. The incorporators are Joseph McCollum, Lloyd Shepard, Charles F. Johnson and Robert H. Lawlor, of East St. Louis, Ill.; Edward Gut, S. O. Fulkerson and C. O. Collier.

MONTANA.

HELENA.—The Missouri River Power Company is reported to have decided to build a second dam across Missouri River, to develop electric power, to cost about $1,000,000.

LIVINGSTON.—President John L. Bright, of the Citizens' Electric Light Company, of this city, has purchased the controlling interest in the Livingston Electric Light Company.

DILLON.—The Dillon Electric Light & Power Company has changed management, the controlling interest of the plant having been sold by Dr. M. A. Miller, of this city, to H. W. Turner, of the Buttle Electric Company.

NEBRASKA.

KEARNEY.—Kuntzen & Isdell, of Kearney, have secured the contract for erecting a power house on the grounds of the State Normal School at Kearney, for $9283.

NEVADA.

RENO.—The Reno Light, Power & Water Company has announced a cut of 75 per cent in its electric lighting rate. This is against the Washoe Power & Development Company, which will turn on current in a few days. The new company is expected to meet the reduction. Recently the Washoe Company offered to furnish current free for the carnival to be given in July, and now the old company comes with an offer to furnish lamps, wires, current and all labor free. Both are wealthy corporations.

NEW HAMPSHIRE.

KEENE.—The contract for lighting the streets has been awarded to the Citizens' Electric Co., of Keene, at $82.50 per year for a 410-watt arc light and $21 per year for 32-c.p. incandescent lights for an all-night, every-night service.

CONCORD.—The Concord Electric Company has closed contracts for the enlargement of its Sewall's Falls plant, and as soon as the work is completed will begin to furnish all the electric power for the operation of the street car lines, an agreement to that effect having been reached with the Boston & Maine Railroad.

LACONIA.—The Committee on Street Lighting of the City Council has taken the preliminary steps for the lighting of The Weirs end of the city by electricity. Already the Laconia Lighting Company, which has a ten-year contract with the city for street lighting, has the work of stringing the wires to the lake well under way. For the first year some twenty-two lamps have been allotted.

NEW JERSEY.

PATERSON.—The Paterson Electric Light, Heat & Power Company has petitioned Council for a franchise for an electric light plant.

CAMDEN.—The Pleasantville Electric Light Company has been incorporated with a capital of $125,000 by Chas. E. Mashold, Augustus H. Riddell and Howard F. Morgan, all of Camden.

CLARKSBORO.—It is proposed to install an electric plant to light the towns of Jefferson, Mount Royde, Clarksboro and Mickleton. A mill at Boody's pond will be converted for the station.

DEAL.—The Elberton Water, Power & Light Company, of Elberton, has secured a franchise to lay mains and conduits for lighting and other purposes in Deal.

JERSEY CITY.—The Sioux City Service Company, of Jersey City, has been incorporated, with a capital of $250,000. The incorporators are Louis B. Dailey, Thomas F. Barrett and B. Stafford Mantz, all of Jersey City.

JERSEY CITY.—The Ajax Light Company, of Jersey City, has been incorporated with a capital stock of $100,000. The incorporators are George M. Wormann, Daniel J. Clark and Harold Morford.

NEWARK.—President Engers, of the Board of Works, has suggested that the city take some steps in the near future to ascertain whether it would be feasible for the municipality to own and operate an electric lighting plant when the contract with the Public Service Corporation expires three years and a half hence.

NEW YORK.

LOCKPORT.—The Niagara, Lockport & Ontario Power Company has purchased a site for the $100,000 transformer station.

POTSDAM.—The Hydraulic & Electrical Power Company has been incorporated with a capital stock of $50,000. The directors are G. W. Sisson, R. L. Sisson and C. H. Sisson, of Potsdam.

TONAWANDA.—The Tonawanda Power Company has secured the contract for lighting the streets and parks with 120 arc lamps for five years at $70 per lamp per year.

NEW YORK.—Plans have been filed for a 4-story and basement brick and stone power-house to be erected at 452 W. 27th Street, by the New York Edison Company, at a cost of $50,000.

OLEAN.—The Natural Gas, Electric Light, Heat & Power Company has been formed; capital, $50,000. Directors: W. R. Page, F. R. Easton and J. L. Page, Olean.

ALDEN.—The Alden Lighting, Heating & Power Company has been incorporated with a capital stock of $200,000. The directors are F. G. Bagley, A. L. Becker, D. E. Klein, Buffalo.

LOCKPORT.—The Lockport Gas & Electric Light Company has filed at Albany a certificate of increase of capital stock from $150,000 to $300,000.

LOCKPORT.—Geo. Schaff, of Buffalo, has secured the contract for constructing a power-house for the Niagara, Lockport & Ontario Power Company, on Niagara River, for about $25,000.

OSWEGO.—The Oswego Light & Power Company has been incorporated with a capital of $100,000. Directors: Henry B. Brewster and Saml. A. Fulford, of Syracuse.

POTSDAM.—Bonds to the amount of $40,000 are about to be sold, the proceeds to be used for the construction of an electric light plant. H. B. Sweet, of Utica, is the engineer.

BUFFALO.—The Niagara Gorge Power Company has been incorporated with a capital of $2,000,000. The directors are J. T. Jones, J. A. Jones, R. E. Powers and H. P. Bissell, of Buffalo.

MINETTO.—The Minetto Light, Heat & Power Company, of Minetto, has been incorporated with a capital stock of $20,000. The directors are C. B. Benson, Minetto; D. B. Page and T. A. Page, Oswego.

OSSINING.—The Hudson Counties Gas & Electric Company, of Ossining, has been incorporated with a capital stock of $100,000. The directors are Moses Ely, A. F. Gotthold and R. R. Logan, New York.

NEW YORK.—The United Public Service Corporation, of New York, has been incorporated with a capital stock of $500,000. The directors are Charles H. Gardner, George W. Peck and A. Edwin Schaffer, New York.

BATAVIA.—The Genesee County Electric Light, Power & Gas Company, of Batavia, has been incorporated with a capital stock of $100,000. The directors are S. B. Storer, Syracuse; R. M. Walker and C. C. Bradley, Batavia.

FISHKILL.—The Southern Dutchess Gas & Electric Company, of Fishkill, has been incorporated with a capital stock of $25,000. The directors are J. T. Smith and E. L. Tompkins, Fishkill Landing, and S. K. Phillips, Mattawan.

PORT JERVIS.—The Orange County Power Company has been incorporated with a capital stock of $50,000. The directors are W. W. Handy, L. L. Marks, New York; Henry Floyd, East Orange, N. J.

TROY.—The Board of Contract and Supply is considering the question of establishing a municipal electric light plant to be used for lighting Monument Square and city buildings in that locality.

NEWARK.—J. L. Rigby, W. L. Mathues and others, all of Philadelphia, Pa., it is stated, have purchased the plant of the New Light, Heat & Power Company. H. M. Whitehead, of Newark, will be manager.

NEW ROCHELLE.—The Northern Westchester Lighting Company has consolidated all the lighting companies in Ossining, Croton, Briarcliff Manor and Pleasantville, and will probably make improvements to the plants purchased.

HOOSICK FALLS.—The Hoosick Falls Illuminating Company has been incorporated to supply gas and electricity, with a capital stock of $150,000. The directors are Roger Lewis, L. C. Tetard, Sherman Cox, R. W. Gifford, of New York, and G. D. Martin, of Greenwich, Conn.

LITTLE FALLS.—The Hudson River Electric Power Company is stated to have applied to City Council, through Attorney Rush F. Lewis, for a franchise to construct a transmission line for the distribution of electricity for lighting, heating and power purposes.

UTICA.—The Central New York Power Company, of Utica, has been incorporated with a capital stock of $1,000,000, to manufacture gas and electricity. The directors are William E. Lewis, Charles B. Watkins, Utica, and Harry S. Patton, Whitesboro.

BUFFALO.—The New York & Lake Erie Power & Transmission Company, of Erie County, has been incorporated with a capital of $100,000 to supply gas and electricity. The directors of the company are J. F. Aldrich, G. A. Ricker, C. F. Powell, Buffalo.

BINGHAMTON.—The Council has awarded to the Binghamton Light, Heat & Power Company the contract for lighting the streets at 23 cts. per night for a term of 3 years for 374 arc lights, and for lighting the city hall and other city property at 6 cts. per kw.-hour.

CASTLETON.—The Castleton Light, Heat & Power Company has been incorporated to operate in Schodack, Castleton, East Greenbush and Rensselaer. The capital stock is $25,000 and the directors are J. D. Smith, T. F. Clifford and F. H. McKnight, Castleton.

DEXTER.—The Dexter Electric Light & Power Company has been incorporated at Albany to furnish light and power in various towns and villages of Jefferson County, capital, $100,000. Directors: Edward Hunter and Catherine J. Hunter, of Dexter; Celestin C. Burns and George H. Burns, of Watertown.

RHINEBECK.—At a recent meeting of the stockholders of the Dutchess Light, Heat & Power Company, of Rhinebeck, the following directors were elected: Frank Herrick, George N. Miller, Thaddeus A. Traver, M. V. B. Schryver, R. Raymond Rikert. Inspectors: Messrs. A. Lee Wager and John Williams.

NORTH CAROLINA.

KINGS MOUNTAIN.—Bids are wanted July 15 for the construction of an electric light plant, to cost about $15,000. J. C. Patrick is city clerk.

MOREHEAD CITY.—Bids will probably be received in July for the construction of water works and an electric light plant.

GRAHAM.—The Graham Water & Electric Light Company has been chartered, with $100,000 capital, by H. L. Millner, of New York, C. P. Hartsell and M. F. Fray, of Washington.

OHIO.

NEWARK.—Electric light bonds to the amount of $15,000 have been sold.

FOREST.—It is proposed to construct an electric light plant here to cost from $5000 to $8000.

FREMONT.—The Fremont Light & Power Company will develop the water power on Sandusky River, near Fremont.

PLYMOUTH.—It was voted to issue $6000 bonds to improve the water works and electric light plant. W. A. Jeffrey is village clerk.

NEWARK.—The Westinghouse Electric & Manufacturing Company has secured the contract for generator, switchboard, arc lamps and regulating

transformer for the municipal electric light plant for about $12,510.

KENTON.—A deal has been closed whereby Richard G. Kerlin and E. M. Kerlin, of this city, come into possession of the local plant of the Kenton Gas & Electric Company, the consideration being $12,000. The Kerlin Brothers will spend about $50,000 in improvements.

NEW STRAITSVILLE.—H. L. Canfield, treasurer Delphos Electric Light & Power Company, Delphos, O., has secured franchises for operating an electric light and power plant at New Straitsville and transmitting current at Shawnee, two miles distant. A complete new installation throughout will be erected and modern equipment installed.

OKLAHOMA TERRITORY.

ANADARKO.—The municipal lighting plant of Anadarko, just completed by the El Reno Light & Power Company, and costing $11,000, was started on the evening of June 4 and the city is now lighted by 28 arc lights. The plant was installed in the water-works power-house.

OREGON.

RICHLAND.—C. F. Hyde and W. H. Strayer, of Baker City, are interested in the construction of an electric plant at Richland.

ASTORIA.—W. W. Whipple has accepted the franchise granted by Council for the purpose of building a telephone, gas and electric light plant in Astoria.

PENNSYLVANIA.

LEWISBURG.—Philadelphia capitalists have purchased the gas works and the electric light plant at Lewisburg.

TAMAQUA.—The Tamaqua Heat, Light & Power Company is reported to have purchased a site for a new plant

READING.—The Reading Illuminating Company petitioned Council for a franchise to erect poles and string wires and furnish light, heat and power.

WILKESBARRE.—The Wilkesbarre Gas & Electric Company contemplates improving its plant, to include changing from direct current to alternating current; adding apparatus of 1350 kilowatts to station capacity; one Curtis turbine, and changing from non-condensing to condensing.

PITTSBURG.—The Johnsonburg Electric Light, Heat & Power Company has applied for a charter. The capital of the company will be $25,000 and the directors for the first year, J. H. Waugh, C. G. Hussey, S. Robinson, A. J. Snodgrass and M. C. Adams all of Pittsburg.

DALLASTOWN.—The York & Windsor Electric Light Company has engaged as manager F. C. Wright, recently superintendent of the Lebanon (Pa.) Edison Company. The Dallastown station has an output of 800 kilowatts and supplies eleven towns in York and Lancaster counties. Eli L. Nissly is president and E. R. Heisey secretary and treasurer.

EASTON.—Under a charter granted to the Consolidated Service Company, of Easton, Pa., a merger of the People's Electric Light & Power Company and the Easton Steam Heating Company has been effected. The charter for the new company, which is capitalized at $200,000, the sum of the capitalization of the two present corporations, was signed by Governor Pennypacker. The officers of the new company in the charter are E. W. Evans, president, and Henry G. Siegfriend, secretary and treasurer.

YORK.—The York Haven Water & Power Company have decided to make an addition to their plant at York Haven. Mr. Henry L. Carter, the president, states that four additional unites will be installed as quickly as possible. This has been made necessary in consequence of the demand for more current. Robert Poole & Co., of Baltimore, are now building the wheels. An addition to the building will be erected to house the units to be installed. The expenditure at this time will be about $100,000. The entire plant will be completed sometime next year, when all of the units intended for installation according to the original plans will be put in. The building will then be extended to the full length of the architect's plans.

RHODE ISLAND.

CUMBERLAND.—The proposition to establish a municipal lighting plant at this place was defeated, by a vote of 153 to 79, by the taxpayers June 14.

CENTRAL FALLS.—The City Council has passed an ordinance appropriating $75,000 for the purchase of a site and the construction of a municipal electric light plant.

SOUTH CAROLINA.

DILLON.—It was voted to accept the franchise recently granted to A. N. Walker and associates for water works and an electric light plant.

CONWAY.—The Conway Light & Power Company has been chartered by the State, with a capital stock of $10,000. D. A. Spivey is president and J. C. Spivey secretary and treasurer.

ROCK HILL.—The Catawba Power Company is making a survey on Wateree, 14 miles below Camden, with a view to constructing a power plant there. Wm. H. Martin, Jr., of Rock Hill, is secretary of the company.

GREENVILLE.—J. F. Grandy & Sons have secured the contract for constructing the dam for the Saluda River Power Company. Orders for machinery and electrical apparatus are reported to have been let.

SOUTH DAKOTA.

YANKTON.—Sandford Donaldson has secured a franchise for an electric light plant.

ARMOUR.—Fred L. Kellogg has secured a franchise for a lighting and heating plant.

MILBANK.—There is an opening here for an electric light system. Mr. H. A. Martens could give further information.

MONTROSE.—Donohue & Williams, of Montrose, write that their electric light plant is about completed, but they desire fixture (electric) catalogues.

TENNESSEE.

WISE.—W. J. Jones is interested in the construction of an electric light plant.

PARSONS.—L. A. Rains and J. W. Fuller are reported interested in the construction of an electric light plant here.

NASHVILLE.—The Southern Electric Company has increased its capital from $20,000 to $40,000 and will enlarge its plant. O. C. Turner is general manager.

LENOIR CITY.—The Lenoir City Light & Power Company, of Loudon County, Tenn., has been chartered; capital stock, $2,500. The incorporators are William Glass, R. M. Galloway and associates.

MURFREESBORO.—The City Gas & Electric Company has contracted with the city for a ten years' service of 75 arc lamps, the franchise being exclusive. Mr. J. H. Nelson is manager of the plant.

CHATTANOOGA.—The Chattanooga & Tennessee River Power Company, of Hamilton County, Tenn., has been chartered, with a $3,000,000 capital stock. The incorporators are Joseph C. Guild and others.

CHATTANOOGA.—The City of Chattanooga has strongly supported, officially, the proposition of C. E. James and J. C. Guild to erect an electric power plant on the Tennessee River at a cost of $300,000. The capital needed is in sight and the company will be chartered in the State of Tennessee.

LAFOLLETTE.—The Lafollette Water, Light & Telephone Company is reported organized, with a capital of $150,000, and will begin construction immediately of water works, an electric light and telephone system. Directors: W. C. Knight, St. Louis, Mo.; F. A. Joss, Indianapolis, Ind., and T. C. Whalen, Indianapolis, Ind.

TEXAS.

DENTON.—The city is reported to have purchased the plant of the Denton Water, Light & Power Co. and will take possession on July 1.

DALLAS.—The citizens have voted to issue bonds to the amount of $100,000 for an electric light plant.

HOUSTON.—The electric light plant at Houston Heights will be renovated and put in operation by O. M. Carter. A quantity of new machinery will be added to the equipment.

DEL RIO.—The Del Rio Electric Light & Ice Company has been incorporated with a capital of $20,000. The incorporators are J. D. Darden, of Jericho; John M. Gray, of Del Rio, and Maynard Gunsel, of Albuquerque, New Mexico.

UTAH.

LOGAN.—The city will install a second unit at the municipal lighting plant. Work is to be completed by September 1.

GARDEN CITY.—The Council is considering issuing bonds for the construction of an electric light plant.

PARK CITY.—The Summit Electric Company has been formed with a capital of $100,000 by Henry Shields, Willard F. Snyder and others, of Salt Lake City, to distribute electric light and power in Park City.

VERMONT.

JOHNSON.—Johnson has voted to secure the Ithiel Falls, and to equip them so as to provide electric power. The estimated expense is $12,000.

STAMFORD.—The Stamford Heat & Power Company has organized with the following directors: John Tudor and Charles D. Houghton, of Stamford; C. H. Cutting, H. T. Cady, E. A. Richardson, J. D. Hunter and F. S. Richardson, of North Adams, Mass. The officers are J. D. Hunter, president; H. T. Cady, vice-president; C. D. Houghton, clerk; F. S. Richardson, treasurer.

VIRGINIA.

FREDERICKSBURG.—The city has voted not to sell the municipal electric light plant and franchise. The proposition was defeated by a majority of 314.

PETERSBURG.—The town of Petersburg is considering the question of municipal ownership of lighting facilities. J. M. Quick is chairman of the light committee.

STAUNTON.—The Blue Ridge Light & Power Company has been incorporated at Staunton by John M. Spotts, president and treasurer; C. P. Bowman, secretary and vice-president. The capital stock is $50,000, and the concern has the right to operate a railroad with any kind of power desired.

RICHMOND.—A move is on foot for the city to operate and maintain an electric light plant. The Virginia Passenger & Power Company now furnishes the light for the city, and this is one of the big assets of the company. The attorneys for the road, it is stated, are not fighting the new municipal light scheme further than to undertake to demonstrate to the Council that it is not to the city's interest at this time to go into such a project.

WASHINGTON.

SUMAS.—H. W. Vanderhoof has asked the City Council for an electric lighting plant franchise.

CHEHALIS.—Harry West, present owner of the electric light plant, will construct a 400-h.p. plant on Coal Creek, north of town.

WISCONSIN.

GREEN BAY.—The Green Bay Gas & Electric Company has decided to expend about $200,000 in improvements.

JANESVILLE.—The contract for lighting the city has been awarded to the Janesville Electric Company, of Janesville, at $62 per light per year for 200 or more arc lights.

WAUWATOSA.—J. M. Harrison, of Milwaukee, has been selected by the County Board and Committee on Public Buildings to prepare plans and estimates for a central heat, light and pumping station for Wauwatosa.

MILWAUKEE.—The electric lighting company of Rio, Wis., is having plans and specifications prepared for one 60-inch turbine wheel, one 75-kw. A. C. generator with step-up and step-down transformers, with 4 miles of lines. Milwaukee Engineering Company, consulting engineers.

American Electrician.

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HYDRO-ELECTRIC DEVELOPMENT IN NORWAY.

ELECTRIC GENERATING STATION AT GLOMMEN NEAR, KYKKELSRUD.

BY L. RAMAKERS.

Of all countries in Europe abounding in water power, Norway excells. Furrowed with multi-branched water courses which plunge from the slopes of the mountains and rush along narrow beds until absorbed by one of the many fjords whose polyp-like arms project far inland, the "Land of the Midnight Sun" possesses natural powers which are both useful and ornamental.

The progress made in the field of electric transmission of power, the multifarious utility of electric energy for industrial purposes, and finally the advantage which hydraulic power possesses in comparison with the mechanical force obtained from coal, liquid fuel, etc., viz.: that the working costs are not influenced by any market fluctuations—all point to the great utility of existing water courses. It was this which led the Aktieselskabet Glommens Traesliberei of Christiania in 1899, in conjunction with the Elektrisitæts-Aktiengesellschaft vorm Schuckert & Co., to use the water of the Glommen for industrial purposes.

The Glommen is the largest river in Norway. The area it covers extends from north to south almost from Tronthjem to Frederiksstad, at which latter place it flows into the Christiania Fjord. Like most Norwegian rivers, the river area of the Glommen also comprises several inland lakes; the largest of these, the Mjoesen, has a superficial area of 559 sq. km. and is situated 123 m. (403 ft.) above the level of the sea.

To the south of Lake Mjoesen, and at a distance of about 60 km. (37 miles) is Lake Oejeren, which lies about 153 m. (502 ft.) above the level of the sea, and communicates with Lake Mjoesen through the Glommen. Some distance below the Oejeren there are several falls of different heights, the aggregate height of fall being 260 feet. The Kykkelsrud, which is about the middle of this series of falls, comprises three falls—the Dalsfos, the Kykkelsrudfos and the Vervenfos, the aggregate height of the fall of which is 64 feet.

FIG. 1.—HYDRO-ELECTRIC STATION AT GLOMMEN, NORWAY.

The water of the fall is collected by a dam at the Kykkelsrudfos, a canal more than half a mile long, leading past the Vervenfos, where the power house is situated. The natural conditions of the spot chosen are

favorable, inasmuch as the river at this place has two arms, one at each side of Haltorp Island, and there is rock all the way across. The dam over the left stream is now completed and is a structure of no small importance. No special difficulties, however, were encountered in its construction. The dam over the right stream will not be built until the consumption of power is increased about 12,000 horse-power, the present installation yielding sufficient water and fall for that capacity. The natural conditions for damming the right stream are essity the canal may be emptied through a bottom outlet above the reservoir, 90 square feet in area; and in order to protect the turbines against stone and gravel the distribution reservoir is placed on a higher level than that of the canal. The pipes leading from the reservoir to the turbines are of concrete or iron and channels are also blasted in the rock. The provisional power house, shown by Fig. 1, has a capacity of four turbines of 3000 horse-power each and three smaller ones, two of 300 horse-power and one of 500 horse-power. are driven by electric motors and work with a pressure of about 30 atmospheres. The turbines were supplied by Escher, Wyss & Co., of Zurich, and by the firm of J. M. Voith, of Heidelheim. The generators were supplied by Schuckert & Co. These are of the horizontal rotating field type running at 150 r.p.m., and generating 2500 kilovolt-amperes, at a tensoin of 5000 volts. The current is three-phase, 50 cycles. The exciters are designed for a pressure of 115 volts and deliver 1580 amperes. The equipment besides these includes six 950-kw.

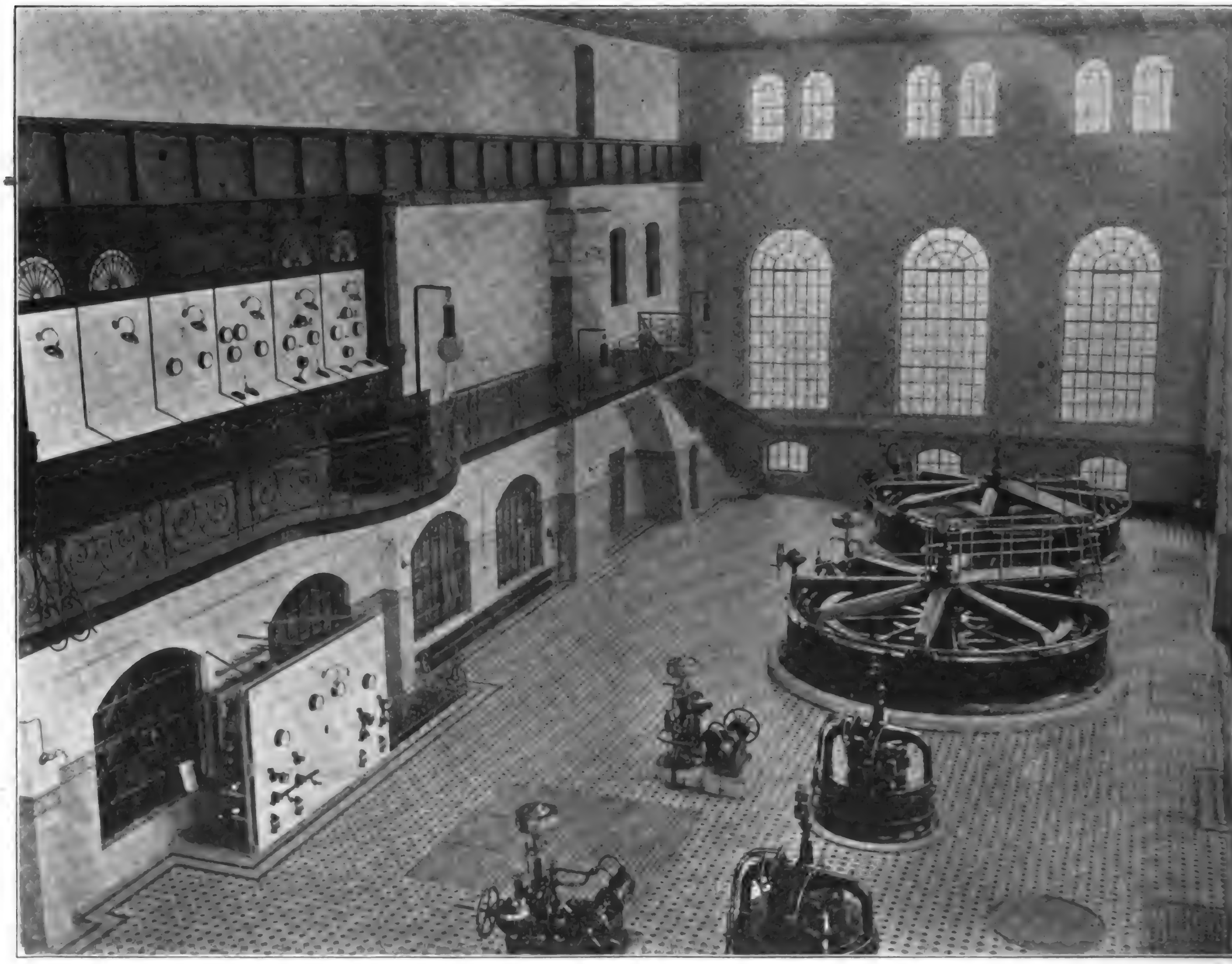


FIG. 2.—INTERIOR OF THE POWER HOUSE AT GLOMMEN.

favorable, there being rock and shallow water right across. Above the dam there will be a reservoir with almost still water.

The inlet canal on the left side of the river is comparatively broad at the upper end, being about 80 feet, and the fall of the bottom of the canal is greater here than in its other parts, being almost 4 per cent on the first 330 feet and on the remaining 3000 feet being 1 to 660, with a breadth at the bottom of 27 feet. The slope at the side of the canal is 1 to 10. The canal is partly blasted in rock, partly dug in earth and in various places concrete walls have been built. A distributing reservoir is situated at the end of the inlet canal, whence the water is conveyed to the vertical turbines in the power house. In case of nec-

When eventually completed the plant will comprise eight turbines of 5,000 horse-power in addition to the four turbines already installed, representing an aggregate of 52,000 horse-power, which is increased to 53,060 horse-power by the small turbines used for driving the exciters. Of this only 43,060 horse-power can be used simultaneously, 10,000 horse-power being held as reserve.

The power station is located at the bottom of the Vervenfos close to the distribution reservoir. It has a length of 155 feet and a breadth of 88 feet. The turbines are placed in the basement and from them vertical shafts 28 feet long go to the generators in the room, directly over the turbines. In the basement are also found the oil pumps required for regulating the turbines. These

transformers having a primary e.m.f. of 5000 volts and delivering a secondary e.m.f. of 20,000 volts.

The main generators are all connected to a common set of bus-bars and from these the circuits lead to the transformer room, where the pressure is stepped up to 20,000 volts; the lines then go back to a high-tension rack above the transformer room. The switchboard for the exciters is situated on the main floor with the generators, as shown in Fig. 2. Fig. 3 is a view of the rear of the main switchboard and Fig. 4 is a view of the transformer room. Special care has been taken to arrange the wires and apparatus in such a way as to be safe in working and within easy control. All the switches, fuses, meters and current trans-

formers and likewise all leads conveying high-tension current are placed in special iron frames and kept separate from the switchboard. This latter has no parts that convey high tension either from the front or from the rear, the rear containing the exciter leads and the wires conveying current to the measuring apparatus. It is also provided with the necessary devices for manipulating the regulating resistance shown above the switchboard in Fig. 3, and in addition with the mechanism for operating the distant high-tension switches. The iron framework shown to the rear of the switchboard in Fig. 3 contains the bus-bars and apparatus carrying 5000 volts. The oil switches for the generators are mounted on top, then follow the corresponding change-over switches and below these the bus-bars with their distance or separating pieces. The measuring instruments and current transformers are inserted in suitable positions and the corresponding fuses are mounted in marble compartments. To the rear of this framework is another somewhat similar, which has mounted on it all of the apparatus and bus-bars carrying 20,000 volts, including the distant lead fuses.

Directly beneath this room and in the rear of the small switchboard shown in Fig. 2 is the transformer room which extends the length of the building. The transformers are situated in the center of the room and on either side of them are tracks, so that each transformer can be erected or removed in the shortest possible time by means of a suitable car. These transformers are of the oil-cooled type.

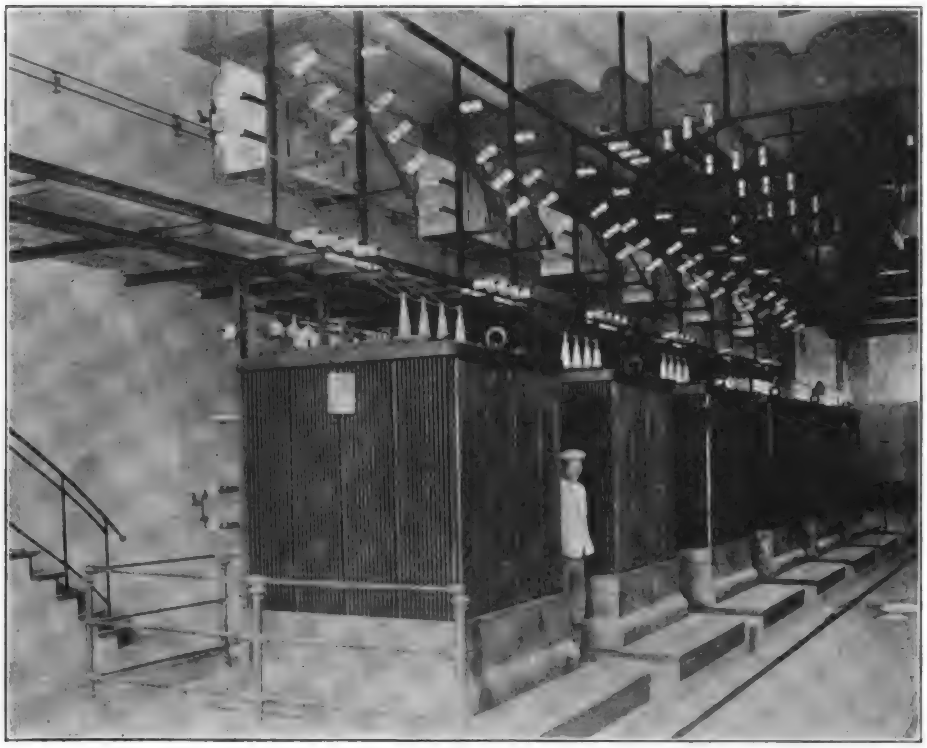


FIG. 4.—TRANSFORMER ROOM IN THE GLOMMEN CENTRAL STATION.

FIG. 3.—REAR OF THE MAIN SWITCHBOARD, SHOWING HIGH-TENSION SWITCH GEAR.

The transmission line is intended to comprise five distinct lines, four running north and one south. The pole lines have already been erected to the north for a distance of 63 km. (39 miles). Each of them is intended for two three-phase transmission circuits, but at present only one three-phase circuit is carried on each pole line. Seven sub-stations are situated along the route of the transmission line. These are provided with oil-cooled transformers for reducing the 20,000-volt current to 5000 volts. Current at this potential is conveyed to various points of consumption, where it is further reduced to 220 volts. Three and a half years were expended in constructing this system, which was placed in operation in September, 1903.

Steel Cables.—In power transmission work spans have occasionally to be dealt with which cannot be carried out with copper conductors, and resort has then to be had to steel cables. The use of such cables would appear to involve an excessive drop. In order to investigate the matter the Allgemeine Elektricitäts Gesellschaft has recently carried out some experiments, the results of which show that the drop with alternating currents is not so much in excess of that obtained with direct currents as might have been expected. The difference increased with the cross-section of the conductor and the current, and decreases, for a given total cross-section, as the strands are made smaller and more numerous.

APPLICATION OF ELECTRIC POWER TO AUXILIARY MACHINERY IN THE NAVY.

BY L. C. BROOKS.

During the last few years considerable progress has been made by the United States Navy in equipping auxiliary machinery such as boat cranes, deck winches, turret gear, ammunition hoists, ventilating fans and small pumps with electric power. The *Kearsarge* and *Kentucky*, which were put in commission in 1900, were far ahead of their day in the application of electric drive, and no particular advancement from these ships was made until the six armored cruisers, *Pennsylvania, West Virginia, California, Colorado, Maryland* and *South Dakota*, known as the *Pennsylvania* class, were developed. These ships, the fastest in the Navy, being of 22 knots speed, will all be in commission by the end of the present year, and are the first of the first-class ships to be fitted with a 125-volt generating plant. The armored cruisers *Tennessee* and class, and the battleships *Connecticut* and class, which are at present building under contract, have an electric equipment quite similar to the *Pennsylvania* class. A comparison of the equipment for these ships will be found in the accompanying table.

TABLE I.—COMPARATIVE DATA.

	Battleships Kearsarge and Kentucky.	Armored cruisers Pennsylvania and Class.	Armored cruisers Tennessee and class.
Date put in commission	1900	1905	1906
Length on load water line, ft.	368	502	502
Displacement, tons	11,600	13,785	14,500
Contract speed, knots	16	22	22
Generator capacity, kw.	350	500	600
Voltage	80	125	125
Turret Turning.			
Guns in each turret	2 8-in. 2 12-in.	2 8-in.	2 10-in.
Est. rotating weight, tons	710	125	235
No. of motors to turn each turret	2	2	2
System of motor control	Ward Leonard	Ward Leonard	Ward Leonard
Motors, how connected	Parallel	Series	Series.
Coefficient of rolling friction	.045	—	—
Ventilation.			
No. of electric fans installed	13	27	27
Nat. air delivered, cu. ft. per minute, restricted delivery		118,800	111,200
Est. current required for above, amperes	1080	800	725
Boat Cranes.			
No. installed on ship	4	4	4
No. motors installed per crane	1	2	2
Capacity of large cranes, lbs.	16,000	33,000	33,000
Capacity of small cranes, lbs.	3,000	5,600	10,000
Electric deck winches installed, number	4	7	6
Electric chain ammunition hoists, number	10	34	30
Electric whip ammunition hoists, number	2	4	3
Electric ammunition conveyors, number	0	0	6
Electric power doors and hatches, number	0	35	41
Work shop, how operated	Steam	Electric	Electric
Fresh water pumps, how operated	Hand	"	"
Drain pumps, how operated	—	"	"
Torpedo air compressor, how operated	Steam	"	"
Laundry machinery, how operated	—	"	"
Turret ammunition hoists, how operated	Electric	"	"
Turret elevating gear, how operated	"	"	"
Turret rammers, how operated	"	"	"

The latest practice for dynamo room arrangement is to have two separate dynamo rooms, complete with generators, pumps, condensers, etc., which are interconnected through switches on the switchboard, so that in case of accident if all of the machines in one room are disabled, the feeders from that room may be supplied with power from the machines in the other room. The distribution switchboards, at which terminate the feeders supplying power to the various auxiliaries and lighting circuits, are located in separate, water-tight compartments. The feeders are run in enameled iron conduit except in very unexposed places, where porcelain hangers are used.

The electric appliances for the auxiliaries are each manufactured under special requirements for each case, which are, in general, as follows:

Motors:—Motors to be wound for 125 volts, direct current.

Motors above 4 horse-power to be multipolar.

The variation of speed between no load and full load of constant-speed motors not to be more than 9 per cent for motors below 5 horse-power and 6 per cent for motors of 5 horse-power and above.

Inclosed motors to be provided with water-tight hand holes of sufficient size for access to the commutator, brushes, field coils, etc., and the leads running through the frame to have stuffing tubes.

The series and shunt field coils of compound motors to be separate. The windings of all field coils to be protected from mechanical injury and no insulating substance used that can be injured by a temperature of 100° C. The armature to be of the iron-clad type, built up of thin laminated discs of soft iron or steel with punched slots and coils easily removable.

The commutator segments to be of hard-drawn or tempered copper, insulated from each other and from the shell by pure mica.

The brushes to be of carbon, to carry not more than 30 amperes per square inch at full load of the motor, and to give perfect commutation without injury to the commutator.

The brush holders to be readily accessible, of the sliding, shunt socket type and made entirely of non-corrosive metal, the springs to be of phosphor-bronze.

All small parts, except permanent fittings, to be of non-corrosive material. All connections liable to become loose to be provided with locking devices.

Controllers:—When located in exposed locations to be absolutely water-tight.

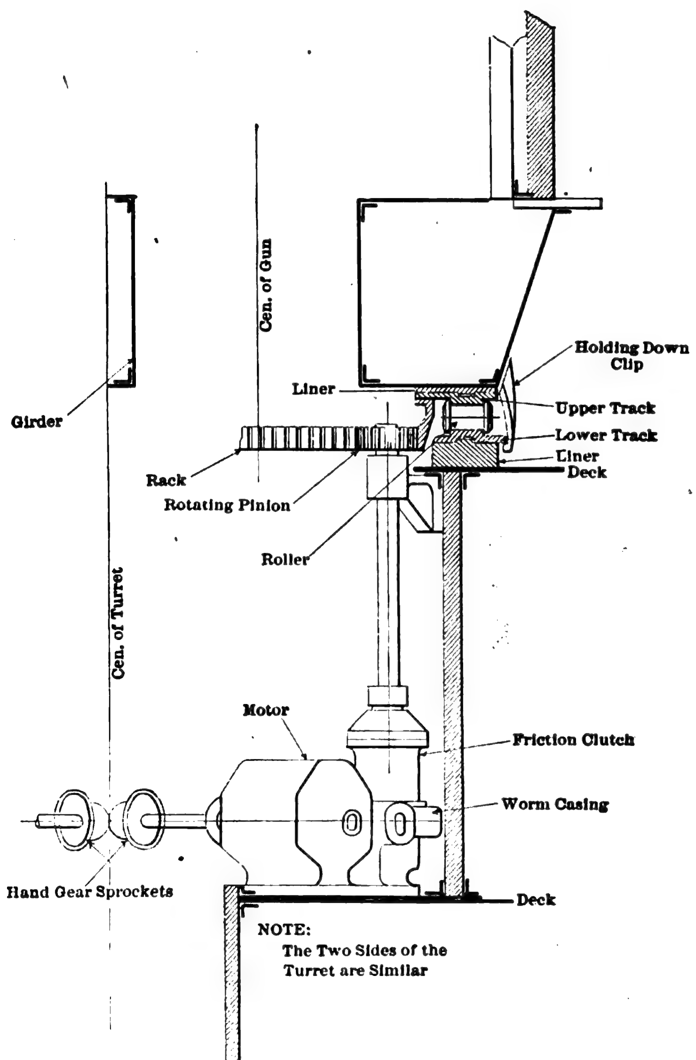


FIG. 1.—ARRANGEMENT OF TURRET-TURNING GEAR.

Fingers and contacts to be of ample size and strength, the fingers to have spring tension.

All flat springs to be of phosphor-bronze and helical springs to be of phosphor-bronze or copper-plated steel.

All insulation to be moisture-proof and fire-proof where exposed to the arcing at contacts.

Operating levers to be easily moved by one hand. The graduations on top of the controller to coincide with the contact points. A notched disc on the controller spindle, held by a spring-operated pawl, to

retain the lever accurately at the various graduations.

All small fittings to be made of non-corrosive material.

Controlling Panels:—Controlling panels to consist of an insulating base with a black polish finish, on the front of which are mounted a main-line switch with enclosed fuses, a starting arm with automatic, no-voltage release and an overload circuit-breaker, the necessary resistances being mounted on the back.

Panels for operating motors of less than 3 horse-power may have a double-pole circuit-breaker operated independently in each lead in place of the switch, fuses and circuit-breaker mentioned above.

Panels arranged for speed control by field resistance to be so constructed that the motor cannot be started on weak field.

Panels arranged for speed control by armature resistance to be so constructed that the starting arm will stay only on contacts designed for continuous running.

The no-voltage release to be responsive only to the line voltage and either bring the starting arm to the off position or open the circuit-breaker.

The circuit-breaker to have independent contacts, must open the armature circuit under any conditions of overload and so interconnected with the starting arm that the circuit-breaker cannot be closed except with the starting arm in the off position.

All insulating materials to be non-combustible, non-absorbent, and not damageable by moisture or heating to a temperature of 150° C.

The frame of the panel to be insulated from the hull of the ship.

The construction of springs, contacts and small fittings to be the same as for controllers.

All resistances to be mounted and insulated such that the result of a burn-out would be practically the same as would occur with an entirely enclosed resistance. All starting resistances to be capable of carrying 50 per cent overload for one minute and 100 per cent overload for 20 seconds.

Rheostats:—The rheostats for each auxiliary to be capable of dissipating heat at such a rate that the temperature in any part shall not rise more than 100° C. above the surrounding air when full-load current is being carried.

The insulating material to be subject to the same requirements as for controlling panels, also firmly secured in and insulated from the supporting frame which is to be insulated from the ship.

The resistance material to be non-corrosive and not damageable by salt water or a temperature of 150° C.

Circuit-Breakers:—The circuit-breakers to be adjustable and able to carry the full rated current of the machine they protect without heating any of the parts and to open the circuit without holding the arc or burning the contacts, which are to be of a simple construction and easily renewable.

Magnetic windings to be thoroughly insulated.

Flat springs to be of phosphor-bronze and helical springs to be of copper-plated steel.

Oxidizable metals, if used, to be thoroughly protected by copper plating.

Tests:—When installing machinery of any character the point that should receive the most attention is the one of preliminary tests.

A small outlay spent in making tests at the time the apparatus is installed, to determine if it will satisfactorily perform the service required, will prove a great saving in the end by decreasing the amount of repairs and loss of time for the apparatus in use.

In the navy work the electrical appliances are tested at the works of the manufacturers by running the motors for a specified time at full load, at the end of which the temperature rises above the surrounding air for the various parts must not exceed the following:

Part.	Open-type motors.	Inclosed motors.
Commutator	40°C	50°C
Field windings	40°C	50°C
All other parts	35°C	45°C
Bearings	30°C	30°C

Tests are also made to determine the fit of parts, balance of the armature, noise, commutation, dielectric strength, insulation resistance, efficiency and speed variation.

After installation on ship the completed apparatus is given a heat run for a specified time under the maximum working conditions to determine if the machinery is strong enough to perform the work intended and the heating of the motors not be above the limits allowed on the shop tests.

Turret Turning Gear:—Each turret is

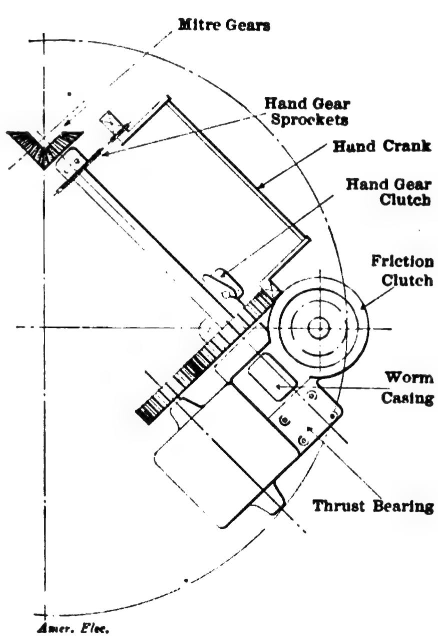


FIG. 2.—PLAN OF TURRET-TURNING GEAR.

turned by two enclosed, shunt-wound motors operating through a system of gearing, a typical arrangement being shown in Figs. 1 and 2. A pinion on the end of the motor shaft engages a gear on the worm shaft, the two motors being connected together by means of a pair of mitres on the extended end of this shaft. The worm drives a horizontal worm wheel which is connected to the vertical shaft through a friction clutch. The rotating pinion, which is secured to the upper end of the vertical shaft, engages the rack which is secured to the upper track, thereby driving the turret. The friction clutch mentioned above is of either the cone or disc type and is designed to protect the gearing from injury due to sudden stopping of the turret, impact of firing the guns or being struck by a shot. During ordinary running conditions it is set down sufficiently to drive the turret without slipping.

Automatic stops are fitted which will turn the controller to the "off" position when the turret reaches the limits of train in either direction. Positive mechanical stops are also fitted as a further safeguard. A dial indicator is fitted in the sighting hood so that the operator may note the position of the turret at any instant. When not being used the turret is held in mid position by blocking wedges.

Great care is exercised to get an accurate fit between the tracks and rollers. The tracks are turned to a true surface and exact size after being secured in place. The rollers are of forged nickel steel and turned to fit the tracks with a clearance of 1/16 in. Holding-down clips secured to the pan of the turret prevent the rollers from leaving the tracks, due to the impact when firing the guns. A hand gear is provided for use when the motors become inoperative from any cause.

Present practice requires the turret to turn at a minimum rate of one rotation per hour and a maximum rate of one rotation per minute. To accomplish this variation of speed with smooth starting and stopping, the motors are operated on the Ward Leonard system of speed control, the motors being connected in series.

This method of speed control depends upon the principle that the speed of the motor armature running in a constant magnetic field is proportional to the volts impressed upon the brushes. This requires a generator for each turret. In some instances one of the regular generators is used, while in others a special motor generator set is installed near the turret.

A diagram of the connections required when one of the regular generators is used is shown in Fig. 3. The field rheostat of the generator is cut out and in its place a special rheostat in the turret is used, which is operated by the controller. The series coil of the generator is shunted by a resistance, so that the series coil may have a slight effect in building up the voltage of the generator and give the turret a prompt start. The brushes of the motor and generator are connected together through the switches, etc., and the fields of each are separately excited from the ship's power.

As the generator is driven at a constant speed, the volts delivered to the motor armature are approximately proportional to the shunt field excitation, which is controlled by the operator in the turret.

When the turret controller is in the "off" position, the motor brushes are connected through a low resistance, so that if the armatures revolve they generate a large current

which produces a powerful braking effect and stops the turret.

By the motors being connected in series, one-half of the working voltage and the total current is available for each motor, thus giving a powerful starting torque and very fine increments of speed.

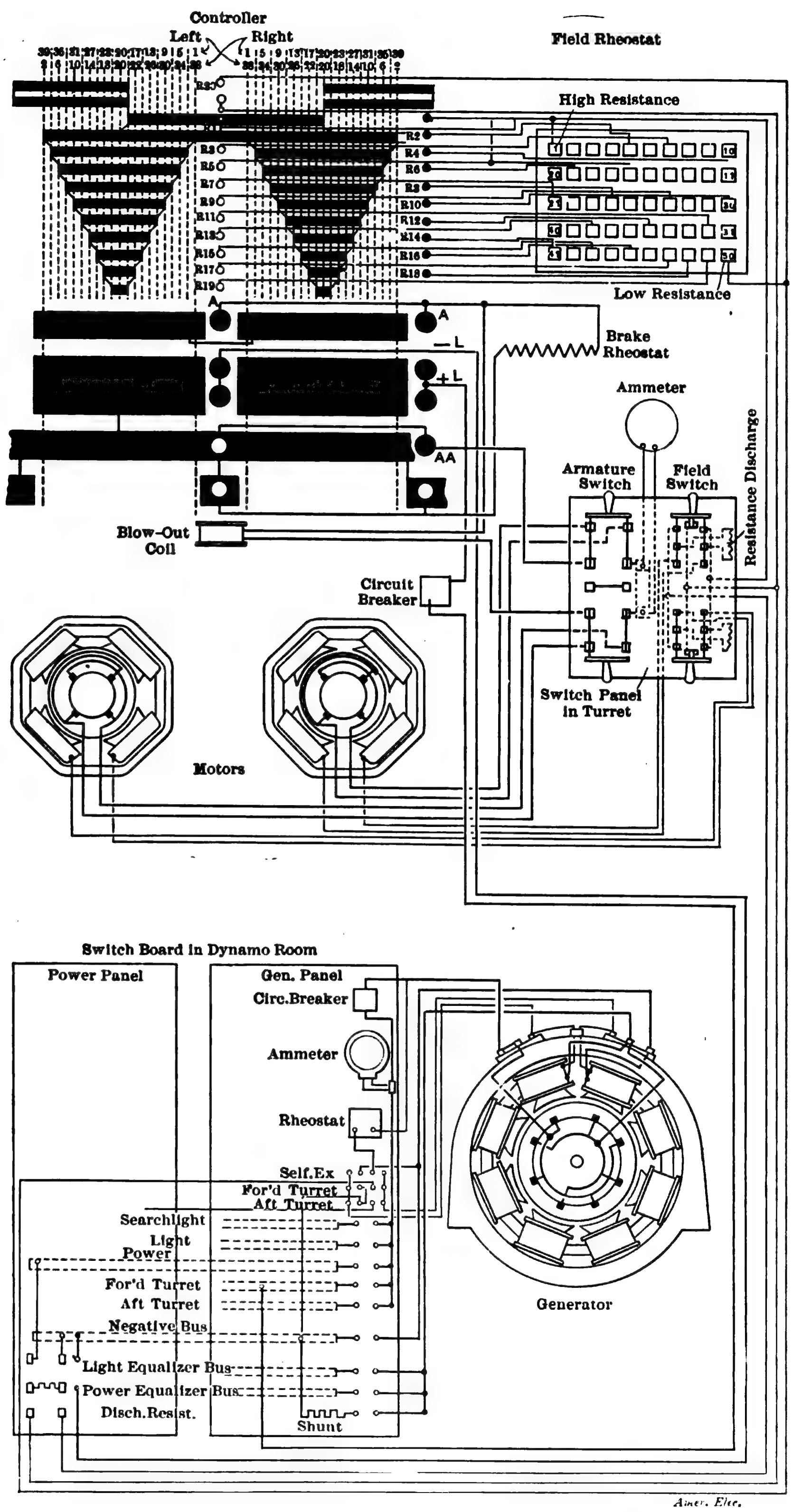


FIG. 3.—DIAGRAM OF CONNECTIONS FOR TURRET-TURNING SYSTEM.

There are usually 25 speed positions on the controller, the first 20 being with the motors at full field at a maximum of about half speed. During the last five positions the motor fields are weakened, the generator rheostat being used and the motors will run at full speed on the last position of the controller.

The motors are of sufficient size, so that should one become disabled it may be cut out by means of switches, and the turret operated by one motor at full field.

Gun Elevating and Loading Gear.—The guns in the turrets are elevated by power and the shells are rammed in the gun by power, hand operation being employed on the smaller guns, 7-in. and less.

For elevating a 12-in. gun, an enclosed, shunt-wound motor is geared to a revolving screw, which raises or lowers a nut cross-head, which operates the gun through connecting rods. In the case of the 8-in. gun, the motor, through a pair of spur gears, a pair of mitres and a worm and worm wheel drives a pinion which engages a segment of a rack secured to the gun carriage.

The elevating motor is operated on the Ward Leonard system of speed control through a reversing rheostat. A small motor-generator set located conveniently near the gun and driven by power from the ship's circuit furnishes the current for the elevating motor.

The rammer consists of a telescopic tube operated through spur and chain gearing by an enclosed, series-wound motor. A friction slip clutch is fitted in the main gear to prevent damage when the shell is seated in the gun.

The motor is operated on ordinary rheo-

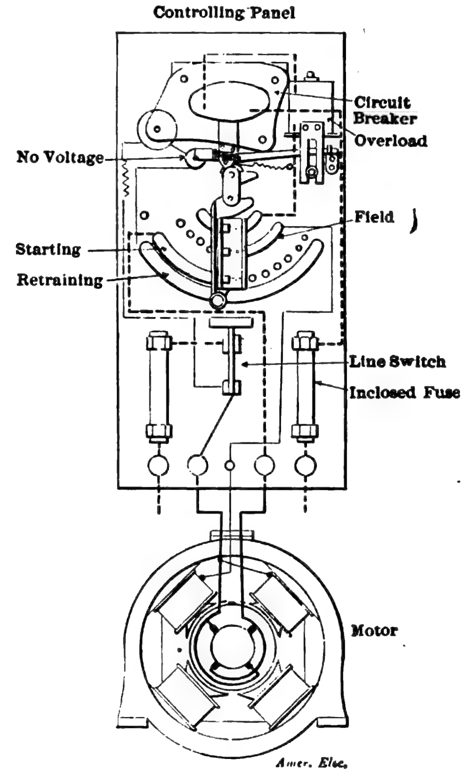


FIG. 4.—DIAGRAM OF CONNECTIONS FOR VENTILATION MOTOR.

static control and protected by fuses as at the instant the shell is seated in the gun a current greatly in excess of the power of the motor is required, while a small amount of current is required when the shell is sliding along the breach.

Ventilation:—The ventilation of a modern ship is very important and a great deal of care is exercised in locating the fans and laying out the piping.

A large number of small size fans are used, thereby reducing to a minimum the piercing of water-tight bulkheads, the number of automatic valves and the amount of water-tight piping. When it is necessary to pierce a water-tight bulkhead, a butterfly valve operated from a convenient point is used, and the ends of ducts leading to magazines and other important compartments are fitted with automatic valves. Adjustable elbows are used for outlets in all

quarters and living spaces and stationary bellmouths are used in other places. Brass piping is used in the magazines, galvanized wrought-steel tubing is used in the coal bunkers and galvanized sheet-steel is used in other places.

It has been found by experiment that the friction of a 20-ft. length of pipe or a 90° bend will reduce the velocity of the air 10 per cent, and allowance must be made for this in designing the size of piping and outlets. Natural exhausts of twice the area of the supply are fitted in all magazines.

All spaces are ventilated on the supply system, except washrooms and water-closets, which are ventilated by exhaust.

The fans are required to be of a sufficient size to give the following changes of air, when running at one ounce pressure: Quarters inside of armor, once in 4 minutes; quarters outside of armor, once in 12 minutes; store-rooms, once in 8 minutes; wash-rooms and water-closets, once in 6 minutes; evaporator rooms, once in 2½ minutes; engine and steering gear rooms, once in 2 minutes; air spaces over boilers and around magazines, once in 2 minutes; dynamo rooms, once in ¾ minute.

The motors are shunt wound, of the open or enclosed type, as the location requires, and operated through controlling panels. They are required to drive the fans at a speed sufficient to deliver the specified amount of air at one ounce pressure and capable of an increase in speed and power sufficient to deliver a specified amount of air at one and one-half ounces pressure, restricted delivery.

The shop tests consist of an eight-hour run at both slow and full speed, the motors driving the fans at open outlet. After the fans and piping are installed on the ship a service test of four days' continuous running at full speed is required to insure satisfactory operation of the motors and proper deliveries of air.

A typical diagram of connections of a motor and a type of controlling panel that has proved very satisfactory in service is shown in Fig. 4.

Boat Cranes: For handling the steam cutters and other small boats, boat cranes are provided to be power-operated from the weather deck. An arrangement that has given very satisfactory results is shown in Figs. 5 and 6. The crane is of the form of a davit, built of structural steel, with a steady bearing at the weather deck and the second deck beneath. At the first deck beneath the weather deck is fitted a roller bearing of sufficient size to support the complete crane with the load. All parts of the crane requiring strength are of steel and designed for a maximum fibre strain of 7,500 pounds per sq. in.

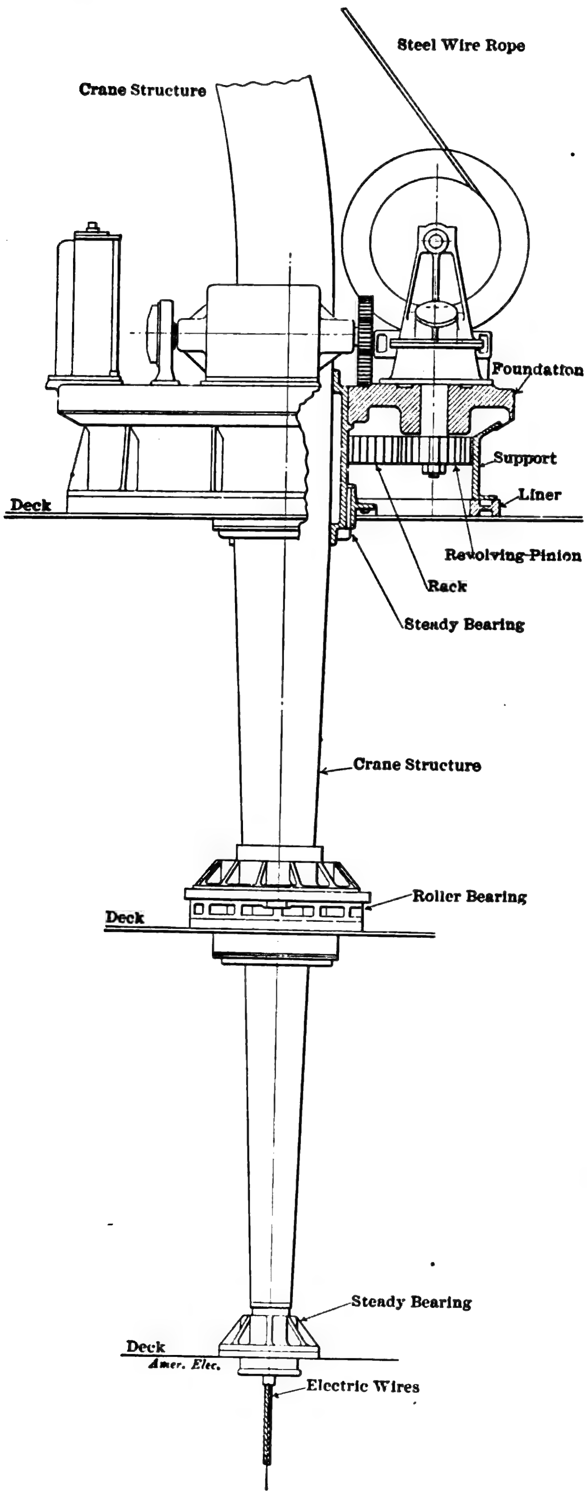


FIG. 5.—ARRANGEMENT OF BOAT CRANE.

The power for operating the cranes is furnished by two inclosed, series-wound motors, one for hoisting the load and one for rotating the crane. The hoisting motor operates through a pair of spur gears, a worm and vertical worm-wheel which is secured to the drum. The hoisting rope leads off the drum over a guide and sheaves in the boom-head to the bottom block and is arranged for two-part or four-part hoisting, according to the size of the load for which the crane is designed. The rotating motor operates through a pair of spur gears, a worm and horizontal worm-wheel and a pinion and rack. The worm-wheel and rotating pinion are secured to the same vertical shaft, and the rack is a part of the support which is secured to the deck, the outboard section being portable. The foundation platform on which the machine is mounted is firmly secured to the crane structure.

The commutator ends of the motor shafts are fitted with magnetic brakes of the disc type which are of sufficient power to hold the full load of the crane.

The controller is of the two-cylinder type, one cylinder for each motor, with the circuit breakers mounted between the cylinders. The rheostats are secured to the under side of the foundation, a manhole in the support providing access for inspection. The feeder wires pass through the lower bearing up inside of the crane.

The most important part of a boat crane equipment is the automatic mechanical brake which is fitted on the worm shaft of the hoisting gear. This brake must be so constructed as to absorb no power when hoisting the load, and control the load when lowering so that the rope speed will not exceed twice the hoisting speed. On account of the great distance through which the load is moved, this brake must be designed with ample allowance for dissipating the heat generated in lowering. Very satisfactory results have been obtained in service with brakes of the Weston type, disc type and cone type.

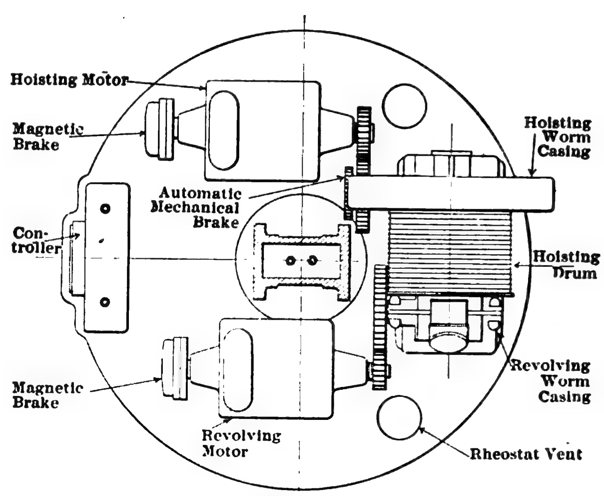


FIG. 6.—PLAN OF BOAT CRANE.

The contacts on the controller are so arranged that the armature of the motor is connected in parallel with a part or all of the rheostats, except in the full-speed positions. This arrangement has especial advantages in lowering by giving gradual increases of speed for the various steps and making very small movements of the load possible. When throwing the controller to the "off" position a temporary stop is provided at the first speed position, as at this point the armature is

short-circuited and the magnetic brake set, thereby assisting the mechanical brake to make a quick stop.

A service test of the complete crane, alternating with the full load and empty hook at full speed for one hour, is required.

With the mechanical parts properly fitted a 16-ton load may be moved a distance of 1/8 in. and a total gearing efficiency of 65 per cent may be obtained.

Deck Winches: For use in coaling ships and other purposes, a number of electrically operated deck winches are furnished.

An inclosed series or compound motor, through a pair of spur gears, drives a shaft, on each end of which is secured a winch head, the motor shaft being fitted with a foot-operated band brake. In one form of winch that is considered quite satisfactory a large casting serves as foundation for the motor and controller, bearings for the winch-head shaft and inclosing spaces for the gears and rheostats, the latter being provided with ventilation.

The controller is of the single-cylinder type, designed for operating in one direction. A reversing switch is provided in case it is desired to operate in the opposite direc-

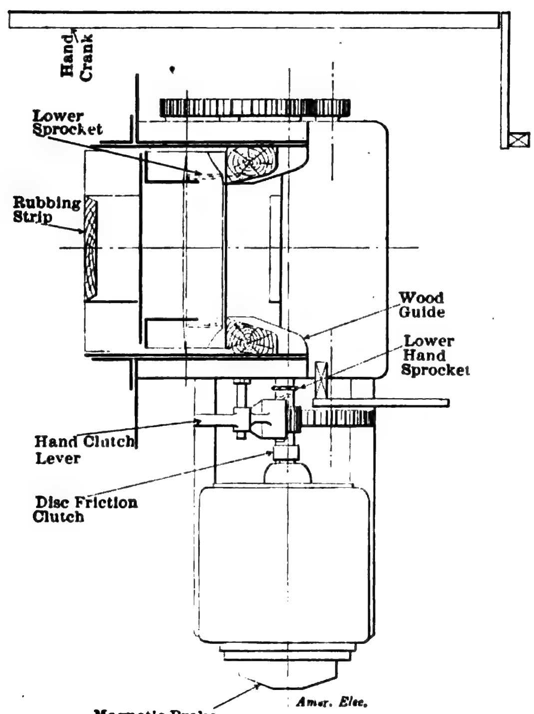


FIG. 8.—PLAN OF CHAIN HOIST GEARING.

tion, and the circuit breaker is mounted inside of the controller case. The motor is operated on plain rheostatic control.

The winches are designed to hoist 2,200 pounds at 300 feet per minute, the rope being led to the winch head through pulley blocks, located to give as direct a lead as possible, and a service test of 1/2 hour at full load and full speed is required.

The winches located on the main deck are also fitted with a compound gear, designed for hoisting 22,000 pounds at 30 feet per minute, which may be thrown in by means of clutches in case it is desired to use the winches for hoisting anchors or other heavy purposes. A total gearing efficiency of 70 per cent may be obtained, which includes the loss in friction of the pulley blocks.

Ammunition Hoists: For hoisting the ammunition from the magazines, electrically operated ammunition hoists are used. These are of three general types: turret hoists, chain hoists and whip hoists.

Turret Hoists: The turret hoists consist of a car with compartments for the necessary shell and powder charge for one fire of the gun and runs on a structural steel track from the handling room to the loading position of the gun.

An inclosed, shunt-wound motor drives

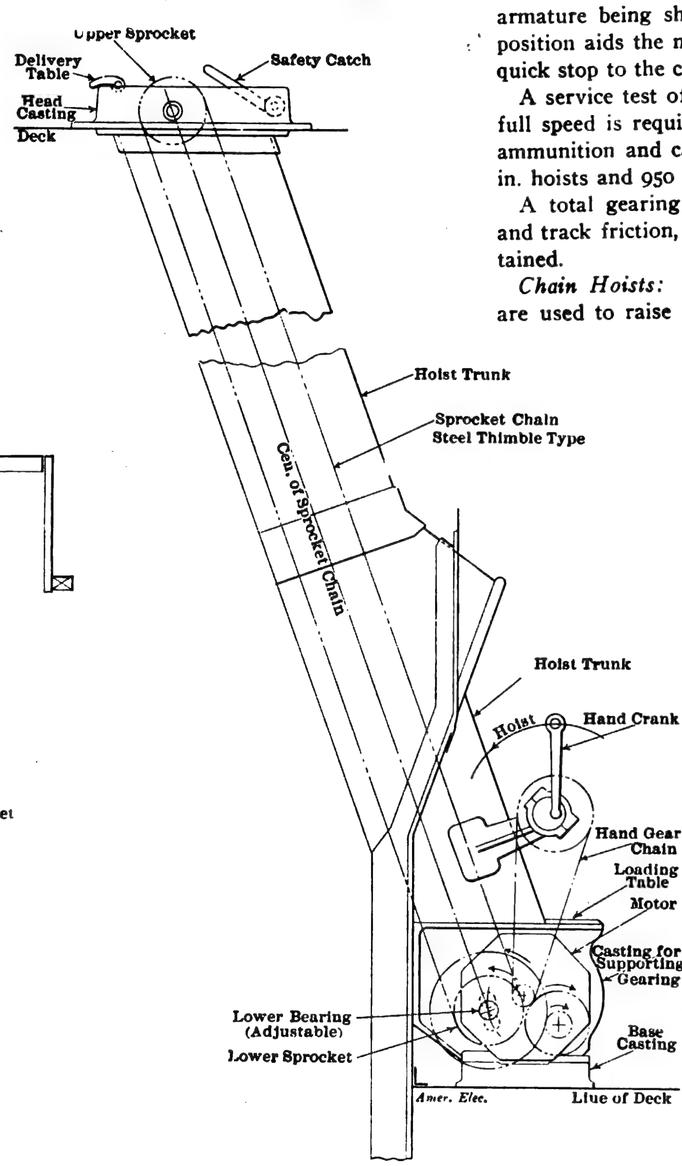


FIG. 7.—ARRANGEMENT OF CHAIN AMMUNITION HOIST.

the drum shaft through a pair of spur gears. One end of a steel wire rope is fastened to the drum, and the other end is fastened to the car, the path of the rope being guided by properly located sheaves. The controller, rheostats, circuit breaker and line switch are located near the breech of the gun, where the operator may be in full view of the car as it passes up and down the track. The motor, as well as the motor for elevating the gun, is located in the pan of the turret or in the central girder.

The motor shaft is fitted with a magnetic disc brake, which sets at the "off" position of the controller and is of sufficient power to hold the full load. The car is fitted with a safety device which will grip the track and prevent an accident should the rope break.

For hoisting, the motor operates on plain rheostatic control. For lowering, the rheostat is thrown directly across the line and at the intermediate-speed positions is gradually paralleled with the armature, which is short-circuited at the "off" position, until at the full-speed position the rheostat is in parallel with the armature. By this means the motor will take current when lowering light loads and will act as a generator sending current through the resistance when lowering heavy loads that overhaul. The armature being short circuited at the "off" position aids the magnetic brake in giving a quick stop to the car and holding the load.

A service test of 1/2 hour at full load and full speed is required. The total weight of ammunition and car is 2,970 pounds for 12-in. hoists and 950 pounds for 8-in. hoists.

A total gearing efficiency, including rope and track friction, of 65 per cent may be obtained.

Chain Hoists: Chain ammunition hoists are used to raise the ammunition from the handling rooms and passages to the vicinity of the small guns, a typical arrangement being shown in Figs. 7 and 8.

An enclosed, shunt-wound motor, operating through two pairs of spur gears, drives the lower sprocket shaft, the sprockets being keyed on. The bearings for this shaft are adjustable to take up the sag in the chain due to wear. Endless chains of the steel thimble type pass over these sprockets to two similar ones which run loose on short shafts at the head of the hoist. The ammunition is placed on carriages which are secured between these chains at regular intervals.

The hoist trunk is built of structural steel and is of sufficient section to allow the ammunition to pass up and down freely. The head of the hoist is provided with a delivery table and safety catch to prevent a charge from slipping back into the hoist.

The hoists are designed for continuous running at a constant speed, the motor being operated through a controlling panel. The end of the motor shaft is fitted with a magnetic brake of the cone type to prevent a charge from dropping should the power fail while operating the hoist.

The motor pinion is fitted with a friction slip clutch of the disc type, which is set to act when the power required by the hoist is excessive due to jamming of the charge in the trunk or other causes. A hand gear is provided for use when the motor is inoperative for any cause. The complete lower gear

is assembled on the base casting and fitted in the ship after the trunk is completed. A service test of two hours at no load is required; also to hoist a limited number of dummy charges of ammunition. The ammunition hoisted weighs from 73 to 134 pounds and the average chain speed is about 90 feet per minute. A gearing efficiency of 70 per cent may be obtained.

Whip Hoists: Whip hoists are used to raise the ammunition from the weather deck, where it is delivered by chain hoists to the small guns located in the military tops on the masts.

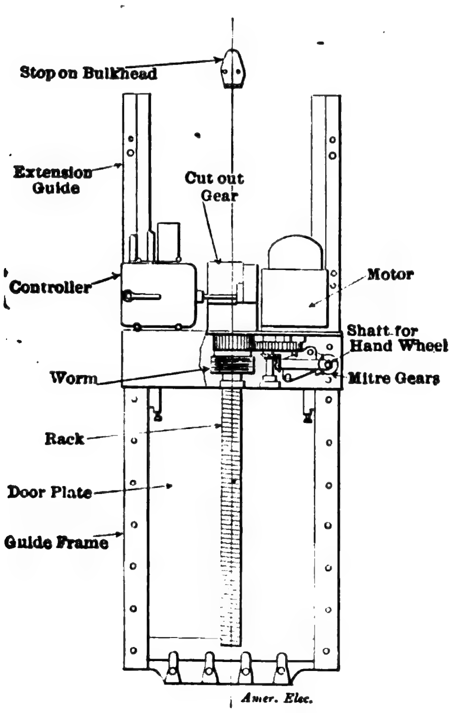


FIG. 10.—ARRANGEMENT OF POWER DOOR.

An inclosed, shunt-wound motor drives the drum shaft through a pair of spur gears. The rope leads through guide sheaves over a sheave on a davit at the point of delivery, with one end fastened to the drum and the other end fitted with a hook. A hollow base casting supports the motor and controller, the circuit breaker and rheostat being mounted in the hollow space.

The motor shaft is fitted with a magnetic cone brake and the speed control is similar to that for the turret hoists.

The rope speed is about 240 feet per minute. A service test of one hour, alternating with the full load and empty hook, is required. A gearing efficiency, including rope friction on the sheaves, of 60 per cent may be obtained.

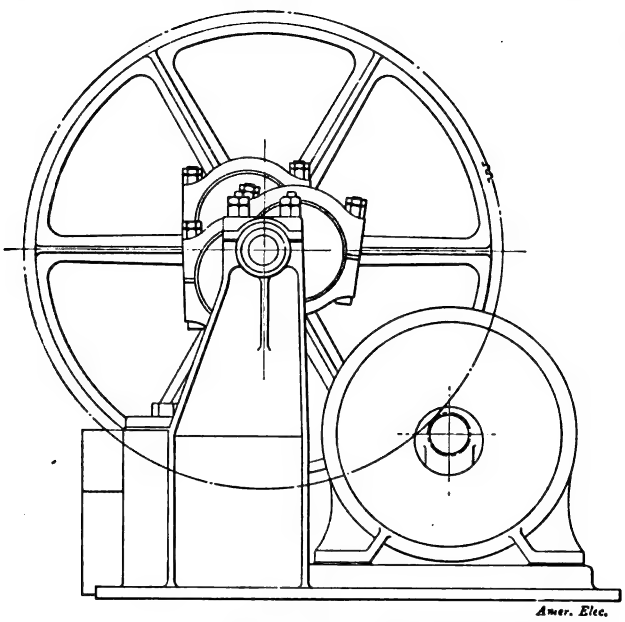


FIG. 9.—ARRANGEMENT OF ELECTRIC PUMP.

Pumps: Electrically operated pumps are used for the drainage system and fresh-water system. The pumps for the drainage system are of the centrifugal type, direct driven at constant speed by an inclosed, shunt-wound motor, operated through a controlling panel.

The tanks for storing fresh water for the ship are usually located in the hold, with a reservoir tank on the bridge deck. The water is circulated through the system of piping and supplied to the reservoir tank by electrically operated pumps. A type of pump that has given very good satisfaction in service is shown in Fig. 9. It is of the three-plunger type with spring valves, the suction and discharge valves operating on the same spindle, all parts being made of gun metal or phosphor bronze. The pump is driven at constant speed through a pair of spur gears by an inclosed, shunt-wound motor, operated through a controlling panel. An efficiency of about 45 per cent, including gears, pump and friction of piping, may be obtained.

The required service test under normal working conditions consists of 8 hours for the drainage pumps and 2 hours for the fresh-water pumps.

Power Doors: The more important hatches in the protective deck and the doors through the principal water-tight bulkheads below the protective deck are operated by power. The doors are of the vertical sliding type or horizontal sliding type, as local conditions require. An arrangement of a vertical sliding door is shown in Fig. 10. An inclosed, compound-wound motor drives a worm through two pair of spur gears. The worm engages a rack on the door, thereby making the movement of the door positive in either direction. A hand gear connection is provided in case the motor becomes inoperative.

The door operates like an ordinary gate valve, water-tightness being secured when the door is fully closed by wedges on the door plate setting up against rollers in the door frame.

The motor is operated through a controller limit switch without resistance. The cylinder is controlled by a spring so that the door may be stopped at any position by simply releasing the handle. The cylinder shaft is connected to a cut-out gear that is fitted on the worm shaft so that when the door reaches its limit of travel in either direction, or strikes an obstruction, the controller will operate and shut off the power from the motor.

The entire system of doors and hatches is arranged to be operated from the pilot house by an "emergency station," which, when once started, automatically closes the circuit of the solenoid on top of the controller. This solenoid operates a pair of contacts on the controller so as to close the door. The "emergency station" is constructed so as to start the doors at intervals of three seconds, thereby avoiding a sudden rush of current in the feeders. Should a door be closing from the "emergency," it may be opened in the regular manner by operating its individual controller handle in the regular way. When the handle is released the door will continue to close from the "emergency."

When the door is fully closed and locked a button on the door plate engages a contact box on the door frame, closing a secondary circuit, which lights a lamp in the "emergency station" so that the commander of the ship may know the position of all of the doors at any instant.

Miscellaneous: Where the ammunition hoist is located at some distance from the magazine the ammunition is transported along the passage by endless-chain conveyors which are driven at constant speed through gearing by an inclosed, shunt-wound motor operated through a controlling panel.

The power for the laundry machinery is taken from a countershaft which is driven at constant speed through a pair of spur gears by an inclosed, shunt-wound motor, operated through a controlling panel. The power for driving the machinery in the work shop is furnished in the same manner as for the laundry machinery. The air compressors for supplying air for torpedo tubes, smoke ejectors for the turret guns and pneumatic tools are driven at constant speed by inclosed, shunt-wound motors operated through controlling panels.

STREET LIGHTING BY INCANDESCENT LAMPS.

BY JOHN HOWATT.

The field of lighting streets electrically has generally been conceded to the arc lamp, but there are cases where an incandescent lighting system might be preferable. The arc lamp as manufactured at present concentrates a great deal of light in one place. In outlying districts of a city or in the residential portion of a village an arc lamp gives more light than is absolutely necessary and more than can be afforded; or, if they be used, they must be installed so far apart that the illumination midway between the lamps is very poor. If the streets are crooked or heavily shaded by trees, the distribution of light will be still worse.

The incandescent lamp lends itself readily

to division into small units, so that for illuminating crooked or shaded streets it is especially applicable. In outlying districts, where one arc lamp every second block is all that can be afforded, the same watt consumption divided up into eight incandescent lamps distributed four to the block gives a more satisfactory illumination.

The arc lamp has also several objectionable mechanical features about it from which the incandescent lamp is free. The incandescent lamp is shadowless, it has a better appearance in the daytime than the arc lamp, and there is no cost of trimming. On the other hand, with the incandescent lamp there is always a greater expense for

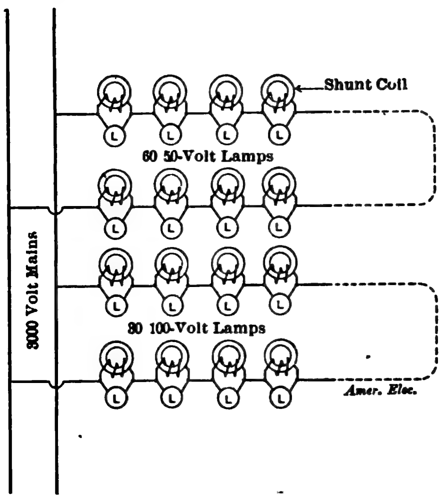


FIG. I.—WESTINGHOUSE SYSTEM OF SERIES INCANDESCENT LIGHTING.

repairs, and the efficiency is low compared with that of the arc lamp.

There are two general systems used in operating incandescent lamps for street lighting. These are the multiple system and the series system. The multiple system is used chiefly in small towns where a special generator or transformer could not be installed. The lamps used are the ordinary multiple lamp, generally of 16 or 32 candle-power. In one town of 6,000 inhabitants, which was brought to the writer's notice, the entire residential portion is lighted by multiple incandescent lamps on 110-220-volt, direct-current, three-wire circuits. Sixteen-c.p. lamps are used, two at each corner placed diagonally across the street, and three more spaced evenly along the block, two being on one side of the street and one on the other. This makes an average of five 16-c.p. lamps per block, or a consumption of about 275 watts per block. While the illumination is not brilliant, it is very uniformly distributed and is sufficient for all except the business streets. The great cost of feeders for such a system, however, prevents its adoption on a large scale.

In some other instances where multiple lamps are used, current is taken from high-potential mains through step-down transformers distributed over the area to be lighted. Each transformer supplies the lights of, say, one block at 110 volts. In this system the lamps are often clustered into groups of three or five. Sixteen-c.p. lamps should be used in preference to 32-c.p. lamps, as the latter lamp is just as liable to be broken as the former, and the cost of repair is materially less in the first case.

The series system of operating incandescent lamps has a much wider application than the multiple system. This is solely because of the great saving in copper this system affords over the multiple system. The lamps themselves are not as economical. The manufacture of a filament to carry 3½ amperes has not yet reached the perfection it has in the manufacture of a filament to carry ½ ampere. Then, too, the complications and imperfections of a cut-out device for each lamp and a regulator for each circuit are introduced in the series system.

There are two main systems of series incandescent lighting in use at the present time. In one a string of lamps is operated in series in a loop across high-voltage, constant-potential mains. In the other a circuit of lamps in series is operated by a constant-current transformer or regulator. There was at one time another system which had a constant-current generator for each lamp circuit, but this has gone out of use.

The first-mentioned series system of incandescent lighting is the one brought out by the Westinghouse Electric & Manufacturing Company. Fig. 1 shows the general arrangement. Either 50 or 100-volt lamps are used, taking about 3 and 1½ amperes, respectively, for a 50-c.p lamp. These higher voltage lamps are preferable in most cases because a lamp with a short, thick filament for, say, 25 volts, cannot be made to operate as economically as one with a longer, thin filament for 50 or 100 volts. On the other hand, the number of lamps in series in a circuit can be greater with the lower-voltage lamps, so that sometimes in long circuits they have to be used.

One of the most important features of any series incandescent lighting system is the means providing a safe path around a lamp in case a filament is broken or burns out. As all the lamps are in series, if one

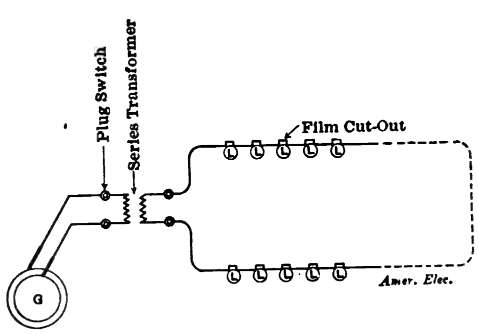


FIG. 2.—GENERAL ELECTRIC SYSTEM OF SERIES INCANDESCENT LIGHTING.

of them should burn out and no other path were provided for the current the voltage about the damaged lamp would rise, destroying the lamp base and putting out all the other lamps in the circuit.

In the Westinghouse system a shunt coil is connected across each lamp to protect it in such an emergency. The device consists of a coil wound on a laminated iron core, magnetized nearly to saturation. It is connected directly across the terminals of the lamp, and under normal working conditions takes but little current. When a filament breaks, however, all the current is forced through the shunt coil, and owing to the high saturation of the core the counter e.m.f. of the coil rises but little above the voltage of the lamp which it displaces. Thus the operation of the other lamps in the circuit is not affected, and the base of the injured lamp is protected from damage by excessive voltage.

The system is one that commends itself for its simplicity and certainty of action. It has the further advantage that the lighting circuits do not all have to come back to the power house, and as no special equipment is necessary, a station already furnishing high-voltage, alternating current can undertake this method of street lighting at a small initial outlay. This system has the objectionable feature that the shunt coil causes a constant loss on the circuit, and when the shunt coils burn out they are rather expensive to repair.

The system which includes a constant-current transformer for each lamp circuit is the one brought out by the General Electric Company. A transformer is used which is the same as the well-known type used for series, alternating-current, arc lighting. Fig. 2 shows a diagram of the arrangement. The transformer is adjusted by counter-weights to give a certain fixed current and regulates for this value very closely. Lamps requiring current ranging from 1.75 amperes to 5 amperes are used. Of course, for any one circuit lamps must be selected which take the same current. On the transformer primary voltages of 1,000 or 2,000 volts are used, while the secondary voltage may range from 1,000 to 6,000 volts. This permits a great range in the number of lamps that can be connected in series in a circuit. Each circuit must come back to the station and is complete in itself through the switchboard and transformer. A film cut-out, located in the base of each lamp, protects the lamp and closes the circuit if any of the filaments burns out. The essential part of this cut-out is a thin insulating film which normally separates the two lamp terminals. If a filament breaks, the voltage across the lamp terminals rises a certain amount until it punctures the film and short-circuits the lamp, thus protecting it, and also keeping the circuit through the other lamps closed. There is no lost energy with this device as there is with the shunt coil, but the system is a more expensive one to install and is not as flexible as the system first described.

Heat Lost by Radiation from a Bare Pipe.—According to a contemporary, a square foot of uncovered pipe, filled with steam at 100 lb. pressure, will radiate and dissipate in a year the heat obtained by the economic combustion of 398 lbs. of coal. Thus, 10 square feet of bare pipe corresponds approximately to the waste of two tons of coal per annum.

A NOVEL SYSTEM OF EMERGENCY LIGHTING.

BY OUR BERLIN CORRESPONDENT.

A system of emergency lighting for use in theatres and other buildings has been devised by Prof. Hochenegg, as shown diagrammatically by Fig. 1 herewith. For simplicity's sake only one group has been represented in the diagram with two individual devices. Each of these includes a direct-current relay, the armature of which carries a metal bow, which, when the armature is released, completes the circuit between the emergency lamp and its battery consisting of three cells connected in series. In place of one emergency lamp two lamps in parallel could be used so that a sufficient amount of light will be obtained in the event of one lamp failing. These lamps are designed for an e.m.f. of 6 volts and consume about one ampere. The relays, batteries, etc., are all connected in series by the two heavy outer wires which terminate in a double-pole switch. If the levers of the latter are placed on *a*, current from the mains will traverse the conductors, relays and batteries of the emergency apparatus. So long as the intensity of the current in each group is above one-half ampere the armatures of the relays are held out of contact with the emergency lamp circuits. As soon, however, as the current falls below this amount, the relay armatures drop, closing the circuits of the emergency lamps. In order to again lift the relay armatures it is necessary to bring the current up temporarily to at least 2.5 amperes.

The current is controlled by a rheostat which is graduated so that the current in a given group of lamps cannot reach the limit of 2.5 amperes per group, so long as the lever does not impinge against the spiral spring. A current in excess of 2 amperes can only be obtained by moving the lever against the pressure of the spiral spring, thus lowering the resistance. As soon, however, as the lever is released the spiral spring throws it back to its contact limit, thus causing the current in each group to drop below 2.5 amperes.

It is evident from the foregoing that the lamps of a given group are readily lighted by interrupting for a short time the circuit of the group in question at any given point. This is effected by interrupters placed at convenient places in the theatre. In order to light the emergency lamps of all the groups simultaneously the current supplied from the mains should be interrupted temporarily or permanently by moving the switch from the contacts *a*. As a possible disturbance in the mains would result in the emergency system being switched out of circuit, the switch could be placed in the central position, *b*, during the time the emergency lamps are operated. The control lamp is then lighted as long as the switch is in this position.

In order to cut the lighting system out of circuit, a sufficiently strong current impulse for each group of lamps should be thrown on the conductors, thus attracting the relay armature and cutting out the emergency lights. This result is obtained by placing the switch on the contacts, *a*, and throwing over the lever of the rheostat against the spiral spring until the current intensity of 2.5 amperes or more is indicated on the ammeter *A*. The batteries for the emergency lights are thus charged automatically, the current being adjusted by means of the rheostat. The second resistance shown is intended for allowing the lighting system to be switched off in case of failure of the circuit. The following advantages are claimed for the system: Each individual emergency lamp, having its own battery, is self-contained and independent of the main lighting system; all the emergency lamps can be inserted simultaneously from one point in the event of a sudden outbreak of fire, while several groups of lamps can be put in circuit independently by means of special switches; any disturbance in the conductor system, due to fire, water, etc., will cause the emergency lights to operate; the total number of emergency lamps can be switched out from one point and the recharging of the batteries occurs automatically as soon as the lamps are switched out; the batteries need not be removed.

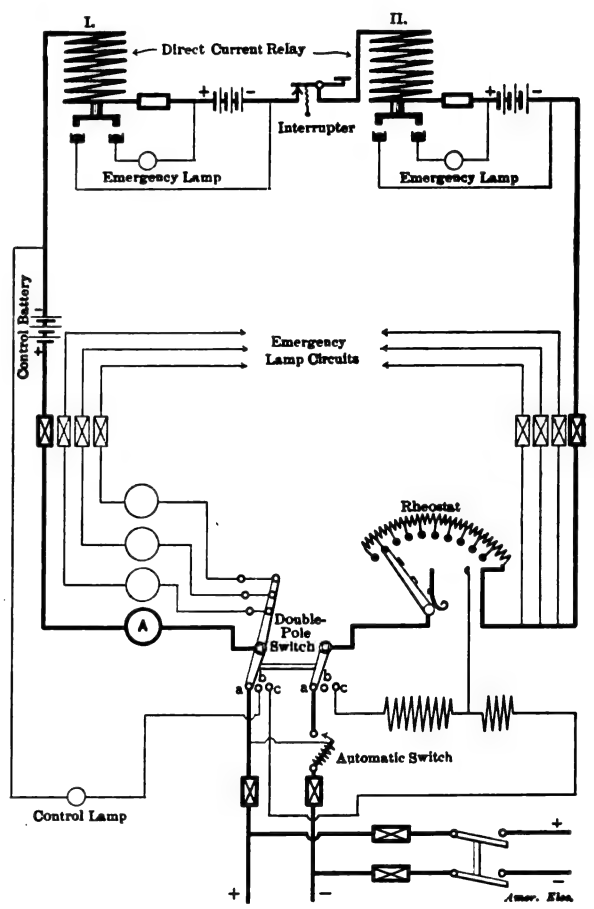


FIG. 1.—SYSTEM OF EMERGENCY LIGHTING.

AUTOMATIC BLOCK SIGNALS.

BY RALPH SCOTT.

The Interlocking Machine.

An interlocking machine which conforms to standard requirements is shown in Fig. 73, which also gives a rear view of the apparatus and the relative relation of the various parts with the position of the locking mechanism. This interlocking machine consists essentially of the case *H*, the controller *C*, the fuse and terminal board *A*, the magnets *I* and *S*, the locking arrangements *G* and the various levers *D*, with their guides, *E*. The frame work is mounted upon one or more pedestals, which support the whole. Machines which are constructed of more than three half sections, usually employ more than one pedestal for supporting the mechanism. Interlocking machines which have a great amount of locking are arranged in what is known as a double tier, from the fact of the locking plates being arranged in two rows, the projecting handles for each row being turned in opposite directions. The fuse board *a*, which forms also the place at which all the connections are made, contains all the circuits with their proper fuses and facilities for making rapid connections.

This terminal board consists of a slate slab across the entire length of which three bus bars run. This slate slab is made in sectional form which pieces altogether along the entire length of the machine. The lower bar is the operating bus bar, all signals being connected to this bus. The middle is the indication bus bar, to which all signals and switches are connected, and the upper is the operating bus bar, all switches being connected to this bus.

The wires coming from the magnets, batteries, circuit controllers, etc., are connected to binding posts mounted upon the slate in the order shown. All fuses and terminals which are connected directly by any lever are placed directly beneath this lever. The reason for such an arrangement is to facilitate interconnection and disconnection either for permanent or for testing purposes. All the connecting wires pass from the various controllers to this terminal board, these being made up into regular sets which are tapped together in a systematic manner. The case *H* is for the purpose of enclosing the levers and controllers, the terminal board and locking mechanism being exposed.

To render all parts accessible for inspection or repair, glass doors are provided in the top of the case. Locking is effected, as already stated, by the tappet bars, guides and dogs, the arrangement of these tappet bars being such as to effect the required cross locking.

Sliding in the guide *E* is the lever *D*, which is held in place by the caps *F* and by the continuous lever guides. This lever has machined within it the cam slot *U*, which gives the desired motion to the tappet bar *V*. This tappet bar, as we have already stated, is shown in its various positions by the circles, which are numbered 1 to 5, the

cam slot representing the exact position of the tappet bar which corresponds with the similarly numbered positions of A'. This sliding contact is connected to the lever by means of the rod w, any movement of the levers thus causing a corresponding movement of this rod, which in the various

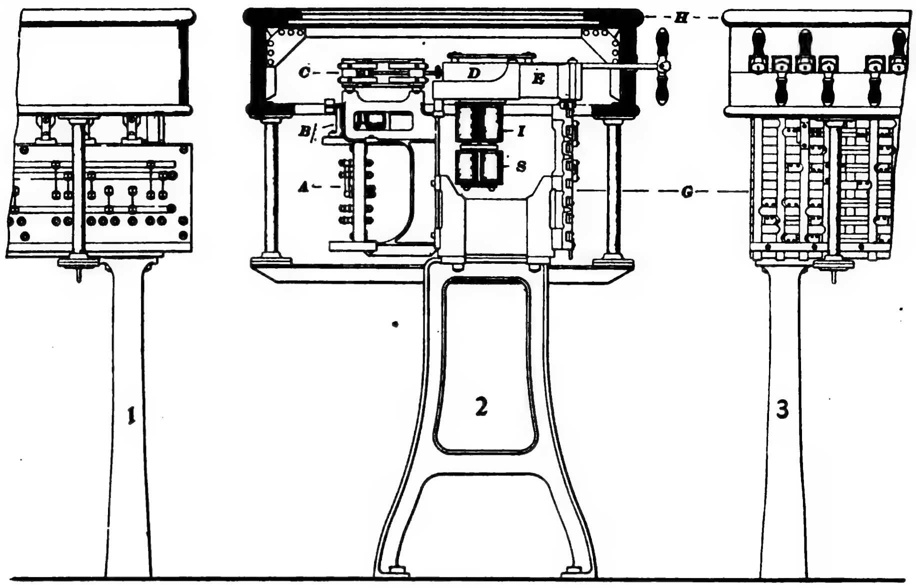
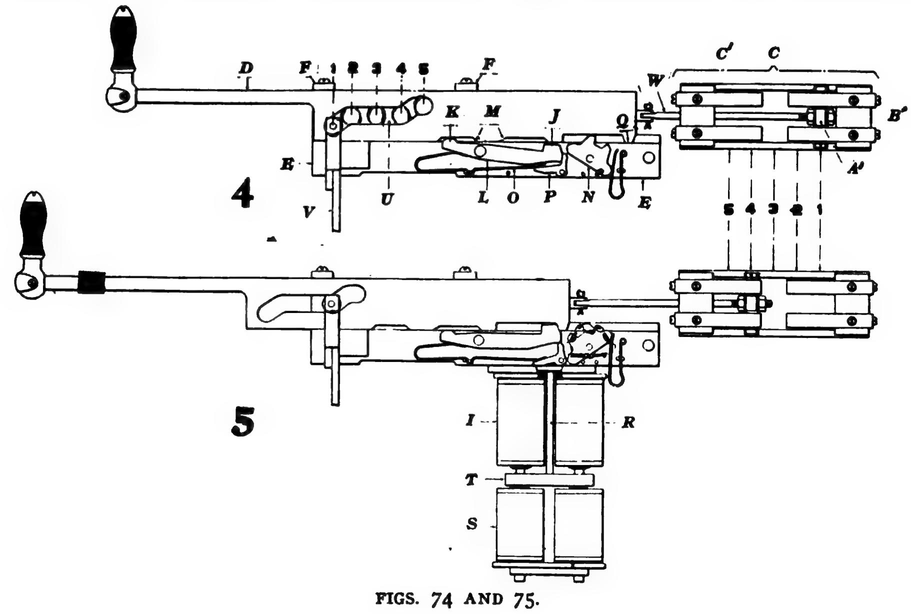


FIG. 73.

positions causes it to assume the positions 1 to 5.

To prevent confusion, the handles are usually of different colors. When two switches are to be operated simultaneously or are solidly connected, a short lever is used for imparting the desired motion. This short lever is not provided with a cam slot, the locking being effected by the long lever. The short lever, however, has its guide controllers and magnets. Fastened to the frame work in the manner shown is



FIGS. 74 AND 75.

the lever guide E. Mounted upon this guide are the springs, dog, cam, latch, etc., which are shown in Figs. 74 and 75, and rigidly held in place by the adjacent lever guide. Secured to the lower surface of this lever guide are the magnets I and S, S being the safety magnet which is used only on the switch levers, and I the indicating magnet common to all the levers. The brushes C' and B', which are connected to the controller C in the manner shown are fastened to the fixed insulating block fastened at the ends of the controller, the sliding contact C' being connected to the rod W. The contact arrangement and circuit relation of these brushes are shown diagrammatically in Fig. 72. According to the various positions of A' they will be thereafter referred to as 1, 2, 3, 4 and 5, depending on the respective positions of the lever.

In connection with all switch levers is an indication selector B, which is operated by the working current, and connected in such a manner that it is moved in one direction with a certain direction of current and in the opposite direction with a reverse direction of current. Either of these may be the normal position. A function of this selector is to close the indication circuit, which has the correct relation to the position of the lever, and which leaves the other circuit opened at the same time.

By following up the changes which occur when a lever is moved through a complete stroke, it is possible to understand the methods employed in preventing the lever from passing from the beginning to the entire completion of this stroke unless everything is in the proper shape to prevent the conflicting of levers or routes.

The motion from the positions 1 to 5 is accompanied by an unlocking of all the levers which conflict, providing, as said before, everything is in the proper condition to admit of such unlocking. In the switch lever shown in Fig. 74, this lever is in the full normal position, while in Fig. 75 the same lever is in the reverse control, an indication position, these positions showing the operation, functions and connection of the various intercepting devices employed for preventing the lever from moving to the full position unless all these accessories are in the proper condition to warrant such movement. When the lever passes from the position 1 to 2, the tappet bar V is raised, which locks every conflicting lever and causes the projection M on the lever D to come in contact with the projection K provided on the latch L, thereby causing the latter to assume the position shown in Fig. 74, such position bringing the projection J directly in front of the tooth Q, as shown in Fig. 75. When the lever passes from position 2 to 3, the tooth Q becomes engaged with a similar projection on the cam M, which causes it to revolve in a horizontal position.

In passing from 3 to 4 the cam N revolves and finally assumes a position shown by the full lines in this figure, the lever being stopped at the position 4 by the tooth Q, which comes in contact with the projection J. At the same time A', having come in contact with the stationary brushes C', closes the battery circuit, which sends current to the motor and causes the switch to be thrown to the correct position, and locked in this position, the indication current resulting on the change in connections being sent through the magnet I and the lifting armature F, thus causing the plunger R to strike the dog P, and throw it from under the latch L. This latch being thus released, drops to its lower position, and thus permits the lever to move from 4 to 5, which completes the stroke; and, by lifting the tappet bar V, unlocks the levers which do not conflict with this new position.

In passing from the reverse to the normal position, the action is similar to the above, with the exception that on the reverse stroke, when the contact A' is in the position 4, the current passes to the magnets I, from the battery, and thus gives an artificial indication, which allows the lever to be passed to the position 5, as already explained. All the signal levers operate in the same manner. Since the function of the safety magnet S has already been explained, its use will be at once evident. The advantages of the operation above defined cause an unreliable indication to be almost impossible for the following reasons: (a) On account of the fact that there is effected both the mechanical and electrical locking of the lever D, this latter could not be moved to any position if any conflicting routes had been set up. (b) If

the lever has been once moved to or beyond the position 3, it is impossible to move beyond the position 4 or backward to position 2 without an indication, which latter cannot be given unless the locking is in a position which corresponds with the position of the lever. (c) Since the lever *D* is free to move, and is forced to stop at the position 4, and thereby prevented from passing to the position 5 without an indication being received, no conflicting levers can be unlocked, which proves positively that the switch has been moved to, and locked in the position which corresponds to the position of the lever.

In Fig. 76 is shown the complete switch and lock movement, which is that provided for a left-hand switch. This movement consists essentially of the motor, switch machine, detector bar and connections. The motor, which is shown at *D*, is of a construction which prevents any weather conditions from being deleterious to the motor mechanism, this being effected by providing the cover with a rubber gasket, the armature shaft itself passing through an adjustable stuffing box. When the cover is removed, the entire mechanism is exposed for inspection.

The motors are so constructed that the power which they are capable of exerting may be varied, by changing the armature and field connections. The switch machine consists essentially of the connecting shaft *A*, lock movement *K*, driving rod *L*, pole changer *E*, gear frame *O*, and the cover, which is so designed as to keep out all snow and rain from the moving system. A flexible universal joint connects the connecting shaft *A* with the motor shaft. The gear frame mechanism *O* performs two functions: first, reduces the speed of the motor and consequently increases the power applied at the switch movement, which is necessary for both this switch movement and detector bar movement; and second, to cut off the motor when the switch has moved to its proper position—that is, has entirely completely its stroke. The main gear shaft has mounted upon it a cam, a clutch shifter, a gear and a pair of clutches, which latter effect the disengagement of the motor from the switch mechanism.

The gear and clutches are both mounted on the shaft, directly connected to the motor armature. The clutches, although free to move parallel to the shaft, are keyed to the latter and when moved to the position which is controlled by the shifter are forced against the gear by springs. Except when one clutch is engaged with another, the gear is loose upon the shaft, the clutches being connected to the gearing, which latter is connected to the motor.

The completion of the stroke causes the clutch to move sideways, this being effected by the cam operating through the shifter, which disengages the motor and allows the armature to maintain rotation by the momentum which has been given to it. The counter e.m.f. set up by the motor during its rotation is utilized to give an indication through the indication magnet, which was explained diagrammatically in Fig. 72. The pin *H* effects the movement of the switch detector bar and lock plunger, this pin being fastened on the main gear, connected directly to the lock movement by the rod *L*, and to the switch by an intermittent motion when engaged with the crank cam *P*.

The lock plunger, detector bar and pole changer are operated through the interposition of the lock movement *K*. The link *N* transmits motion to the crank *S* by the rod *L* and to the lock plunger by the link *I*, the plunger and detector bar being both driven by the cam crank. A movement of the former would be impossible if a train be on the track in the near vicinity of the switch, since the prevention of motion of the detector bar prevents any movement of the plunger.

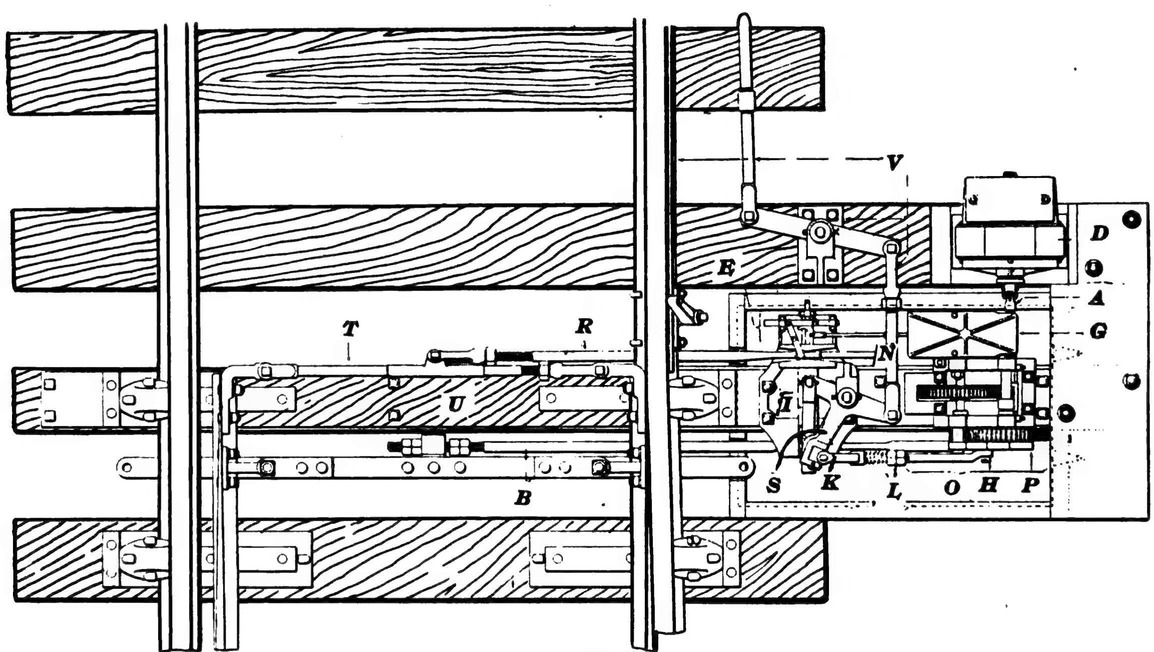


FIG. 76.

Therefore, the switch cannot be thrown under these conditions. By means of the pole changer movement, *E*, after the lock plunger in returning has passed entirely through the hole in the lock rod, *R*, motion is imparted to the pole changer, *G*. The pole changer, *G*, by the action of two pins on the lock rod, *R*, causes this pole changer to be thrown in one direction when the switch has been thrown to the normal position, and in the other direction when the switch has passed to the reverse position. This movement of the pole changer cuts the working current from the motor, reverses the armature connections and finally completes the indication circuit. These operations and the switch connections have been described in Fig. 72. The pole changer is either operated mechanically or electrically, the latter being effected by the magnets in the manner which we have already explained. The circuit breaker, which cuts off current from the magnets when the switch has reached its full normal or reverse position, has a revolving character, the entire switch being enclosed in a cast iron case.

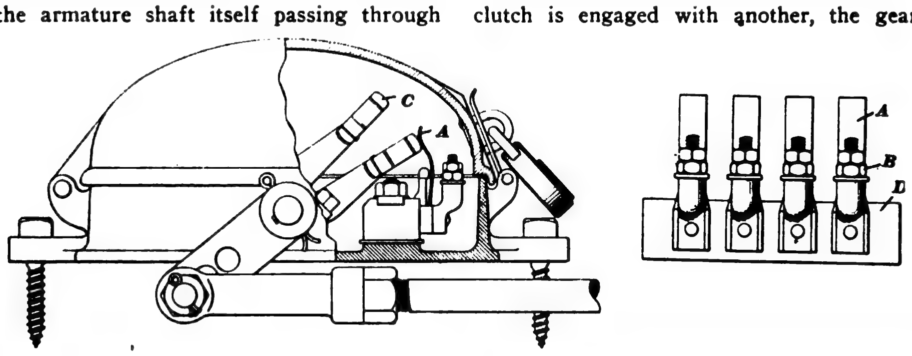


FIG. 77.

This switch is illustrated in Fig. 77 and consists of the insulated contact bars *C* which make connection in both positions of the stroke by the stationary contact pieces *A*, fastened upon an insulating block *D*, to which connection may be made by the posts *B*, the whole being enclosed in a suitable case which is padlocked to prevent tampering. Securely bolted and braced to the rigid tie plate *U*, which is placed above and upon the face of the tie, is the gear frame lock movement and rails, this plate

thus maintaining all the parts at their proper distance from one another.

The lock and front rods are shown respectively at *B*, *T* and *R*, the former and latter being bolted to the lock plunger, the detector bar being shown at *V*. Taking the switch movement as a whole, we have the following operation: Current having

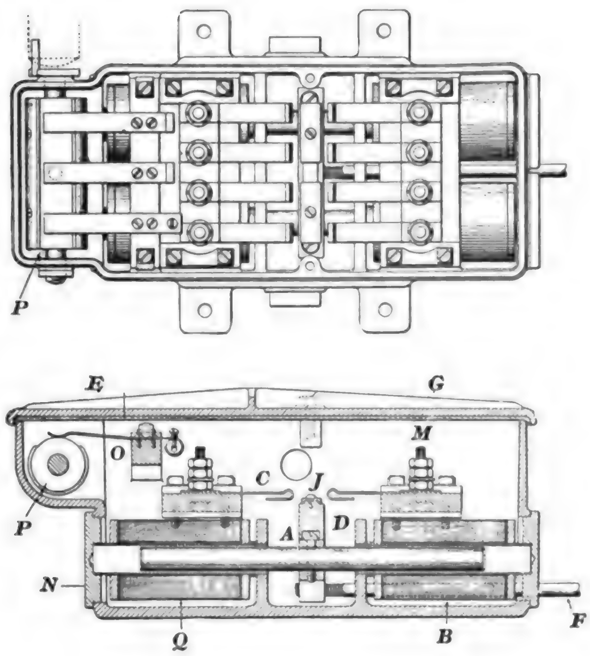


FIG. 78.

been delivered to the motor in the manner shown in Fig. 72, the latter is set in motion, and, through the interposition of the train of gearing, causes the main gear with the pin above to pass through a complete revolution. At about one-third of this revolution the lock bolt is withdrawn, the detector bar being at the same time moved to its upper position.

When this has been accomplished, the pin mentioned above, by coming in contact with one end of the crank cam *P*, throws the switch during the next one-third of the revolution. The lock rod is returned to its original position, and the detector bar lowered during the final one-third of the revotution. When the lock plunger has passed through the lock rod, the pole changer is thrown, the motor at the same time being disconnected and disengaged as explained above, thus resulting in an indication through the indication magnet as already shown.

The detector bars are generally fifty feet long and, consequently, require a powerful force to move them. In the manner explained above, it is impossible for the switch to be thrown if the train be within fifty feet of the switch point.

In Fig. 72 was shown in diagrammatic form a single arm high signal. This signal includes the signal movement proper and a circuit breaker. The signal movement includes an electric motor, a train of gears, and a magnetic brake; this brake acts upon the motor armature and brings it, when necessary, to an almost immediate stop. The circuit breaker consists essentially of a frame with a suitable cover, the entire housing being fastened to the signal pole. The frame carries a set of fixed contacts, together with a sliding contact with the necessary operating mechanism. Supported within the frame are two vertical and parallel strips upon which the fixed contacts with the binding posts are mounted. The operation of this circuit breaker is as follows:

When the signal arm descends it moves a rod within the circuit-breaker downward; a spring encircling this rod is thus compressed. When the semaphore has reached the full clear position, the upper contacts are disconnected and the lower contacts connected to the fixed contacts carried on the bar. The upper contacts control the motor and brakes, the lower ones being used to complete the circuit of the distant, if such an arrangement is used. When it is desired to break the circuit of the switch mechanism by this means, an independent set of fixed and sliding contacts is provided, which open the switch circuit as soon as the semaphore starts to move to the clear position.

Taken as a whole, the operation of the signal is as follows: Current having been delivered to the signal motor by the reversal of the interlocking lever, the armature is set into rotation, and, acting through a train of gears, moves upward a chain fastened to a counter weight, which latter is connected to the signal arm by an iron rod, thus moving the latter to the clear position. When the semaphore has reached

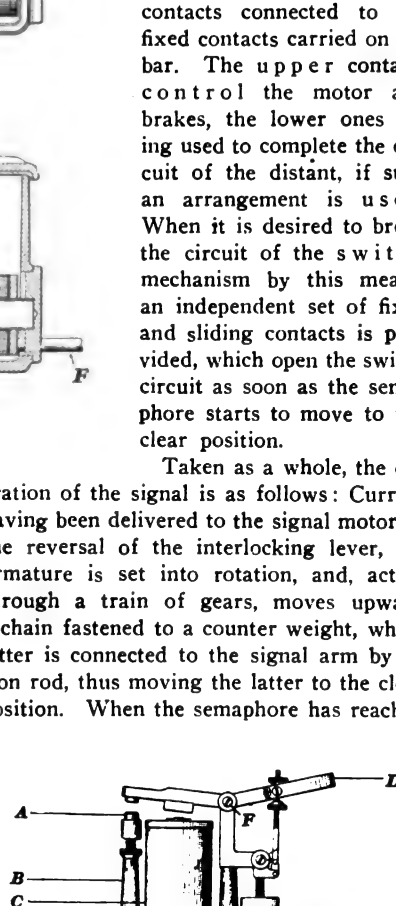


FIG. 79.

the clear position, the circuit breaker opens the lower set of contacts and closes the upper set, which latter sets the brake, and also immediately stops the motor, thus preventing the momentum of the moving system from causing a breakdown. If it is necessary to cause the signal to assume the danger position, the lever on the interlocking machine is moved to its normal position, which takes all current from the brake magnet and motor, and causes the circuit to be completed through the motor and indication magnets, which thus open the signal circuit breaker.

The motor being now free, the action of gravity on the counter weight causes the latter to fall, thus turning the motor backward and at the same time causing the semaphore to move to the danger position. At the instant that the semaphore has arrived at this position, the circuit breaker closes the indication circuit, and the motor, which by its continued revolution acts as a generator, sends current through the indication magnet and releases the lever, the diagram of the connections in this case being already explained.

If the semaphore should come against its stop position before the brake has been set, the flexible connection *D* prevents any injury being done to the mechanism. Any failure of current or electrical or mechanical connection will cause the signal to immediately assume the danger position. The same arrangement is used in two-arm and three-arm signals.

In the dwarf signal the operating means consist of a double solenoid connected to circuit breakers, these being located in the base of the signal and held in place by a frame surrounding the solenoid. When this solenoid is energized, the working coil exerts a pull of sufficient strength to move the signal to the clear position and also to compress a powerful spring which forces the arm to the danger position when the current is cut off.

The general manner of producing power for the operation of the Taylor system is by means of a storage battery, which is charged by a portable generator operated by a gasoline engine, although if it is possible to obtain commercial current at 110 volts, an electric motor is often substituted for this gasoline engine; or, a switchboard is provided which allows the battery to be charged directly from this commercial circuit, without employing either a motor, engine or generator. The voltage employed in operating switches and signal is 110, which requires that 55 cells of storage battery be used, the capacity of these cells depending entirely on the number of train and switch movements during a certain time, the battery employed being of sufficient capacity to make it unnecessary to charge them oftener than once a week. Since the electric current is used exclusively for the operation of switches and signals, it is possible to have the signal lamps thus lighted, which is a matter of great economy over ordinary oil lighting, especially if a large number of these lamps be used.

The generators employed are shunt wound, operating at 1400 r.p.m. At each signal tower from which the signals are operated by the interlocking signals, a switchboard is provided, which is of the standard form used for ordinary commercial lighting.

A reversible pole changer which is fastened to a switch machine is shown in Fig. 78. This consists of the rod *F* attached to the solenoid core *A* by the insulated piece *D*. These solenoids, *Q* and *B*, are operated by current from the switch machine motor. The insulated piece *A* carries the contact strips *J*, which make and break connection with the contact clips *C*, connected, as shown in Fig. 72, to the binding posts *M*. A circuit closer *P* in the form of a drum is operated by the movement of the switch mechanism and makes (at *F*) armature *D*, which is weighted adjustably at *G*, makes contact with the carbon contact *A*, adjustably placed on the post *B*. Where very heavy currents are to be controlled, the arrangement shown in the lower part of the figure is used. An auxiliary coil *J* in series with the contact *H*, and independent of the coil *I*, is provided. The purpose of this coil is to blow out the arc immediately when the circuit is opened at *H*.

An extensive application of the Taylor system is shown in Fig. 80, which represents the complicated arrangement of north, east, south and westbound signals on the Chicago, Rock Island and Pacific; Lake Shore and Michigan Southern; Illinois Central; and Chicago, Milwaukee and Northern Railroads, at their intersection at Sixteenth and Clark streets, Chicago, Ill. This diagram is given to show the extreme applicability and perfect protection afforded by this type of signal.

Although American railroads in general prefer the normal clear system, the reasons for this preference are not because this system has greater relative merits, but to a sort of "follow the leader" habit which seems to be established.

The fact that the initial cost of the installation of the normal clear system is greater than the normal danger system cannot be doubted or denied, but the running expense is greater in the normal clear system, because of the fact that the track battery is short circuited when the signal is at the danger position, caused by the opening of a switch, and also the signal slot magnets are normally taking current from the battery.

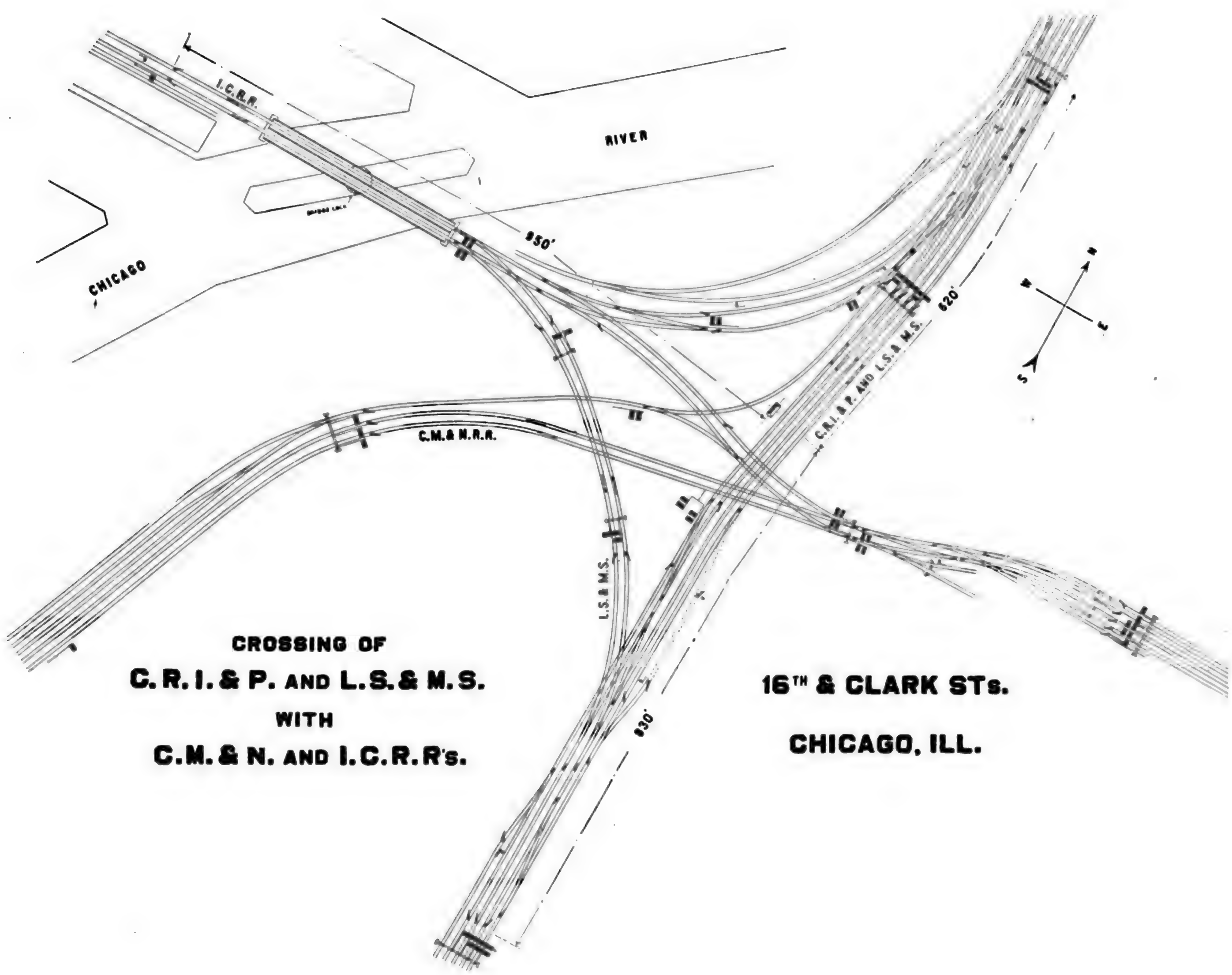


FIG. 80.

or breaks contact with the clips *O*. This mechanism is enclosed within the cast-iron box *N*, provided with the cover *G*, which is gasketed by the rubber pad *E* to prevent the admission of water or moisture.

When the Taylor signal is applied to the ordinary track relay system, a special form of track relay is necessary, which has contacts capable of making and breaking a circuit carrying a large current at 110 volts.

Such a relay is shown in Fig. 79, and consists of the electro-magnet coils *C*, connected, through the binding posts *E*, to the track in the usual manner. The pivoted

However, the following cannot be denied:

(a) THE PRIMARY OBJECT OF A SIGNAL IS PROTECTION. It is not designed to serve the purpose of an ornament.

(b) THE TENDENCY OF THE MOVING SYSTEM OF A SIGNAL IS TO REMAIN IN THE POSITION WHICH IT OCCUPIES FOR THE GREATEST LENGTH OF TIME.

(c) As far as protection is concerned, IT IS BETTER TO HOLD A TRAIN FALSELY THAN ALLOW IT TO MOVE ON WHEN A DANGEROUS CONDITION EXISTS. The importance of (C) can better be shown in answer to the question: "Which is to be preferred, a wreck or the loss of a few minutes' time?"

Abstracts from Foreign Contemporaries

Ageing Coefficient.– According to the *Elektrotechnische Zeitschrift*, the hysteresis commission of the Verband Deutscher Elektrotechniker has introduced a new term, "ageing coefficient," defined as the percentage increase of the "loss coefficient" after the material tested has been heated to 100 C. for 600 hours. The "loss coefficient" is defined as the iron losses, expressed in watts, in one kilogram of material at a flux density of 10,000 lines per square centimeter, at a frequency of 5c cycles per second and with a magnetizing current the voltage curve of which follows the sine law.

A Novel Type of Dynamo.—The Berlin correspondent of the London *Electrical Review* contributes an article on the new type of dynamo previously described in the *Elektrotechnische Zeitschrift*. The dynamo is primarily intended for train lighting. It possesses two striking characteristics: the development of an e.m.f. whose direction is independent of the direction of rotation, and the development of a current which, beyond a certain speed, remains practically constant, even though the speed be increased indefinitely. The method by which these results are obtained is evident from Fig. 1. A storage battery *Q* supplies current to the lamps when the train is at rest. This is connected to the field winding *ff* of the dynamo and produces the polarity indicated by the letters *nn* and *ss*. The main brushes *BB* are placed in a line with the pole pieces. When the train is at rest the battery is prevented from sending a current into the armature through *BB* by the action of an aluminum cell included in the circuit, which only permits a charging current to pass. The auxiliary brushes *bb*, which are at right angles to the line of the pole pieces, are short circuited. If the armature is rotated either way the short-circuit current which passes between *bb* produces a powerful cross field, indicated by the letters *NN* and *SS*. It is this cross field which acts as the main field with respect to the main brushes *BB*. Since the direction of this field will be reversed with a reversal of the direction of rotation, it follows that the polarity of the main brushes *BB* is independent of the direction of rotation. The field produced by the winding *ff* is very weak, so that no sparking difficulty is experienced with the main brushes. The charging current delivered by *BB* produces a cross field along the line of the pole pieces, which tends to wipe out the weak field due to the winding *ff*. It is evident that this will prevent the current from increasing beyond a certain limit, for beyond this limit the field due to *ff* will be entirely wiped out, and this would cause the machine to lose its e.m.f. Thus beyond a certain speed the machine should deliver a practically constant current. By adjusting a rheostat included in the field circuit *ff* any requred limit may be set to the current. The machine may be driven by belt from a pulley on the car axle, or, if the machine be large, the armature may be mounted directly on the axle itself. When run as a motor the machine behaves somewhat similar to a single-phase induction motor in that it possesses no torque when at rest, but when started in either direction will go on running in that direction. It exhibits the general characteristics of a series motor when running, the speed decreasing rapidly with an increase in load.

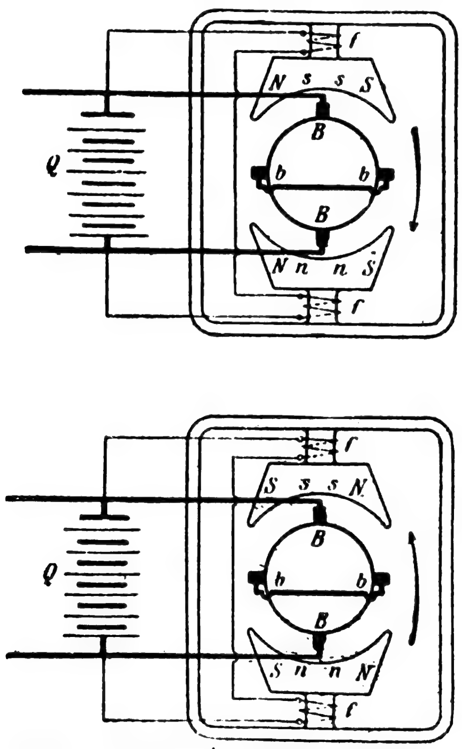


FIG. 1.—ROSENBERG'S INGENIUS DYNAMO.

Catgut Belting.—The durability and advantages of twisted catgut cord for driving purposes is referred to by Mr. Raffard in an article in *Revue de Mecanique*. The relative strength of catgut greatly exceeds that of the best leather, and it has been found in practice that gut cords will work effectively for long periods under a tension of 4,267 pounds per square inch, or ten times the load of leather belts. A round cord of catgut 0.39 in. in diameter would do the work of a leather strap 6 in. wide by one-fifth in. thick. In order that this material may operate under the best conditions, it should be manufactured as an endless belt, and not put together with hook or screw fastenings at the ends, as is usual in catgut lathe belts. Although such fastenings are very convenient in practice, they tend to greatly diminish the strength and durability of the belt; a joint made in the process of manufacturing the catgut cord is about 20 times as strong as the ordinary hook or screw eye fastening. As gut cords can only be obtained in small diameters, it is suggested that they should be used on grooved pulleys similar to those employed for rope drive.

Remarkable Engine Performance.—*The Engineer*, of London, contains the results of tests made on what it believes to be the most economical steam engine ever constructed. The consumption of steam per indicated horse-power per hour during one run was only 8.585 pounds. The engine is an inverted vertical compound of the marine type, with unjacketed cylinders nominally 21 in. and 36 in. in diameter by 3 ft. stroke, and was built by Cole, Marchent & Morley. Each cylinder had four piston valves, the admission valves being opened by eccentrics and closed by springs through a Dobson trip gear; the cut-off on the high-pressure cylinder being controlled by the governor and on the low-pressure cylinder by hand. The exhaust valves were opened and closed by eccentrics. Steam was supplied by a Lancashire boiler, and superheated in an independently fired Schmidt superheater containing 1,033 square feet of surface exposed to the gases and 11½ square feet of grate fire. The exhaust from the high-pressure cylinder was dried and superheated in the reheater before entering the low-pressure cylinder. The exhaust was discharged into a specially erected surface condenser in order that the steam consumption might be ascertained by measurement of the air pump discharge. This condenser had about 1,200 square feet of surface. In all, six trials were made—two at maximum load, two at about three-quarters load, one at rather more than half load and one at the lightest load possible, viz., driving the mill shafting only. During the tests the temperature of the steam at the stop valve of the engine was about 720° to 750° Fahr. and the steam consumption per indicated horse-power per hour was as follows:

471 indicated horse-power	9.187 lbs.
341 indicated horse-power	8.784 lbs.
258 indicated horse-power	8.742 lbs.
145 indicated horse-power	8.585 lbs.

The thermal efficiency of the engine, calculated on the basis of the method proposed by the Institution of Civil Engineers, gives about 22.07 per cent. The engine was said to have been working nearly a year before the tests were made. During the trials it ran most satisfactorily, without a leak anywhere and with every bearing cold. After stopping one of the high-pressure steam valves was taken out, and both the packing rings and the liner in which it worked were found in perfect condition. An incident which speaks well for the construction and workmanship on the engine occurred the day before the tests were made. The pyrometer on the superheater stuck at about 650° Fahr., and the fireman, thinking that the heat was not high enough, fired hard until the first indication of something wrong was that the covering of the pipes took fire. A thermometer was then placed in the engine stop valve pocket and indicated 840° Fahr. When it is realized that this means black red it will be granted that the engine will work satisfactorily with an abnormally high superheat.

New Lock Nut Washer.—There have been numerous devices and special designs of nuts and washers, or a combination of both, to make trustworthy lock-nuts. The latest that has come to our notice appears in *The Engineer*, of London. The feature consists of a washer which has a V-shaped projection diagonally across it. This collar fits into a recess in the bottom of the nut, the recess being made exactly to fit the collar. By this means when the nut is being tightened the washer is also turning with it. It is claimed that it is so difficult to loosen the nut, since it cannot move unless the washer moves, that it will always remain tight. The bear-

FIG. 2.—LOCK NUT WASHER.

ing surface of the washer being greater than that of the nut, the friction, and consequently the resistance to motion, is greater than if the nut were simply bedded on the washer without the projection.

The Leitner-Lucas Train Lighting Dynamo.—The London *Electrician* contains an illustrative description of the Leitner-Lucas system of train lighting which is in use on many European and Asiatic railroads. The dynamo is usually designed to generate a practically constant voltage over a wide range of speed. As will be evident from the diagram of connections shown in Fig. 4 the voltage regulation is electric and purely automatic, the mechanical device shown to the left being a reverse current cut-out. The illustration

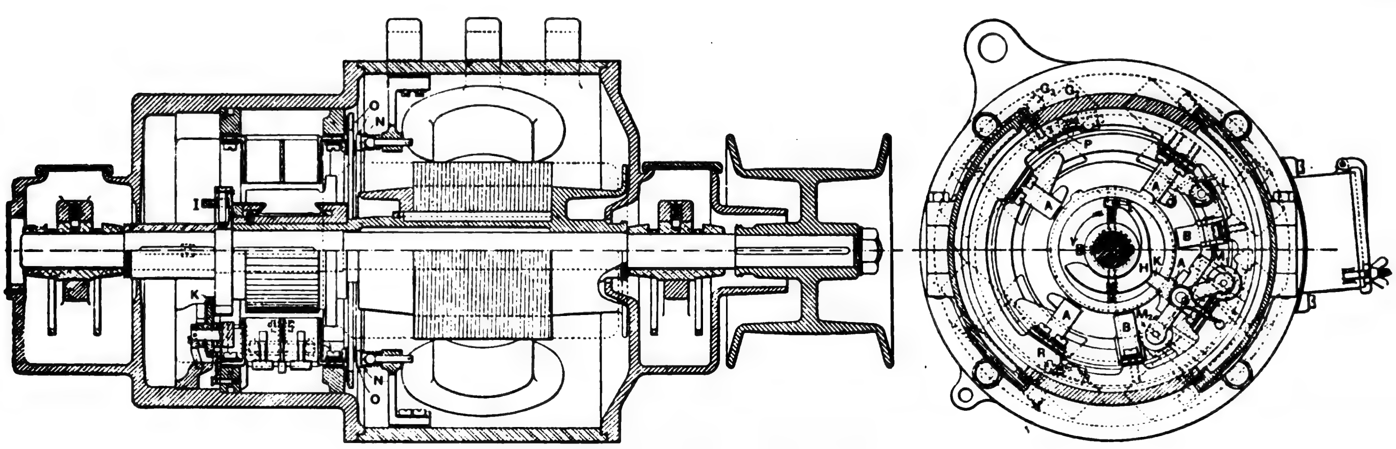


FIG. 3.—LEITNER-LUCAS GENERATOR.

represents the improved form, differing from the system formerly used in that one dynamo armature now performs the work previously done by two. In the old system, a small generator called the demagnetizing dynamo was keyed to the shaft of the main dynamo and served for weakening the field as the speed increased, thus causing the voltage at the dynamo terminals to remain practically constant. In the improved arrangement, however, this auxiliary machine is dispensed with, its place being taken by an extra pair of brushes, D D_1, bearing on the commutator. At starting terminal D_1 is positive and D is negative, so that the voltage between D and D_1 assists that at

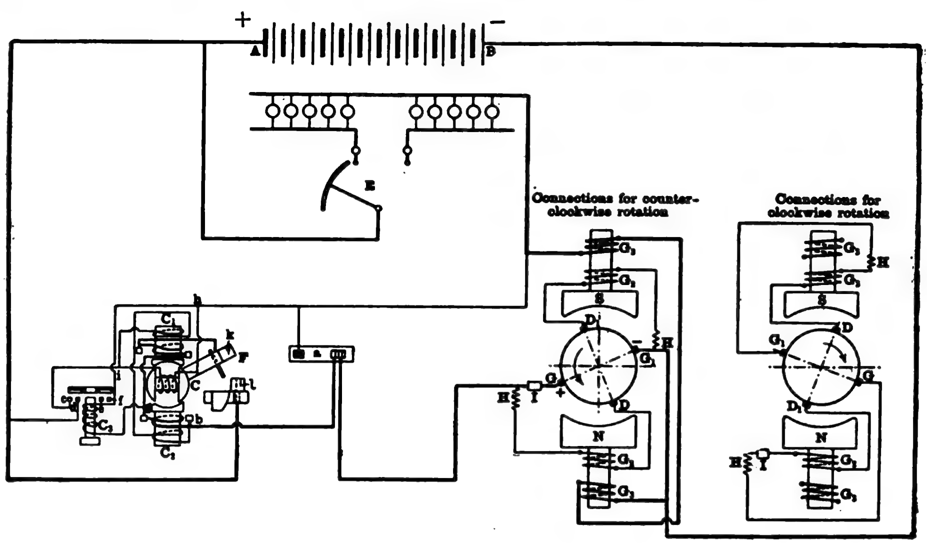


FIG. 4.—LEITNER-LUCAS TRAIN LIGHTING SYSTEM.

the main brushes in sending the exciting current through the field coils. The fields are thus rapidly built up; but as the current flowing out of the armature, G G_1, increases, the armature flux in the direction of G G_1 also increases and the original voltage between D and D_1 is gradually reduced and then reversed in direction, D_1 becoming negative and D positive. As the dynamo speeds up the voltage between D and D_1 rises and chokes the shunt current through G_2 more and more; the result being that the dynamo voltage is kept at a constant value. G_3 in Figs. 3 and 4 is a small field coil in series with the lamps and carries current as soon as the lamp circuit is closed by the switch E. While this auxiliary coil is not absolutely necessary, its use is advantageous as it renders the excitation of the dynamo quite positive and independent of the remanent magnetism. G_2 is an ordinary shunt winding across the main brushes, G G_1, and is protected at either end by a fuse, H. As actually constructed the generator has 4 or 6 poles, two of which are for the excitation. The automatic switch, C, performs the function of cutting the dynamo from the battery circuit whenever the back e.m.f. of the latter exceeds the voltage of the former. When the dynamo voltage has reached a value sufficient to charge the battery, the battery is again automatically cut in. Fig. 3 shows the details of the generator. The frame is of cast steel with cast iron end covers and laminated pole shoes. Its complete weight is about 3 cwt. and its normal output is from 40 to 50 amperes for a 12-cell battery (i. e., 24 to 32 volts). The four main brushes are marked A, the auxiliary brushes being denoted by the letter B. L is a small wheel with a toothed periphery fixed to a spiral spring and when turned one way or the other increases or diminishes the pressure on the carbon brushes. The action of the reversing mechanism is as follows: A suitably shaped metal piece, H, carrying the pin, I, rotates with the shaft. At normal speeds the heavy part of H is forced outward by the centrifugal force against the springs, and the pin, I, passes underneath the trigger, K, of the reversing mechanism. When the train is moving slowly the pin, I, strikes K, but the latter gives way and a faint tick is heard every revolution. When the train comes to a standstill, the pin, I, is farthest from the shaft, and when the train begins to move in reverse direction the trigger, K, is struck from the opposite side, and since it cannot

give way in this case the whole brush is caused to rotate. M_1 is a small trolley wheel which runs on a segment, and the backward rotation of the brush gear occurs only so long as M_1 runs on this segment. If the trolley wheel M_1 runs beyond this segment the trigger, *K*, gives way again to the pin, *I*, and the clicking sound is heard until pin, *I*, is drawn down on the shaft by the centrifugal force acting on *H*. The spring stops, *P*, *R*, prevent the brush gear from overshooting the mark. Instead of using flexible conductors in connection with the movable brush gear, suitable collectors, *N*, bearing on metal segments, *O*, are used. When supplying about 40 amperes at 26 volts no sparking is discernible at the dynamo brushes for speeds varying from 400 to 1500 r.p.m. A single battery with special Planté positive plates is used.

Telephone Protector.—*L'Industrie Electrique* contains an illustrated description of the protective device for telephone apparatus which has been devised by M. Van Deth, and possesses some advantages over the ordinary heating coil. The device is shown by Fig. 5 herewith and consists of a small solenoid, connected in series with the line. If an excess of current passes along the line the plunger of the solenoid lifts and in so doing strikes a detent and thus releases the spring of a contact which opens the circuit. The plunger of the solenoid then resumes its original position and the device may be reset by pressing on a projecting knob. The advantages claimed for this device over the

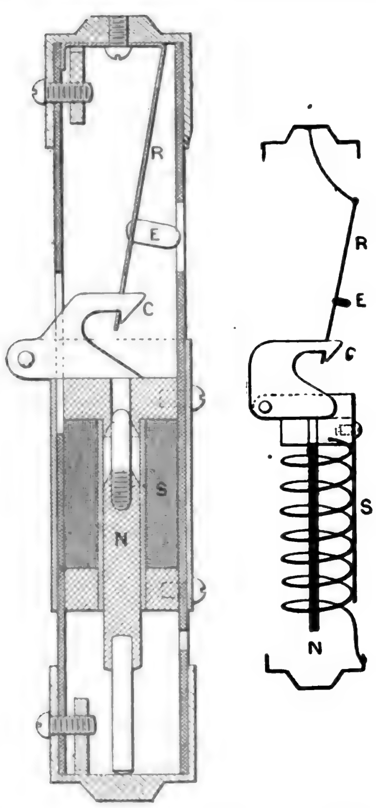


FIG. 5.—VAN DETH TELEPHONE PROTECTOR.

heating coil are the smaller resistance, the quick opening of the circuit, the easy resetting of the device and the inductance of the coil which assists the lightning arrester in its operation.

Street Lighting.—Our English contemporaries contain E. E. Hoadley's paper on street lighting read before the Incorporated Municipal Electric Association. The major portion of the paper is devoted to the lighting of side streets, where arc lamps are out of the question. In this respect the Nernst lamp has been found an efficient substitute. He gives his experience with this type of lamp at Maidstone. The author has some 350 posts at the present time, most of them having a ½-ampere lamp rigidly fixed and suspended from a swan-neck at the top of the existing gas column, the burner being about 11 ft. from the ground, each lamp being housed in by the upper part of a special reflector which is used to get a better distribution of the light. Clear glass globes are used, the general public preferring brilliancy to good distribution, although a good many prism globes were used at first. There are also some 30 posts fitted with the new type lamp, but these have been in use for so short a time that the author cannot speak with any certainty as to their performance. The former type, however, has been in use at Maidstone for about three years, and during this time the life of each individual burner has been kept very accurately, and from the results obtained from a good many hundreds, it is found that the average life is 676 hours, and this has somewhat improved lately. Very few resistances fail, but there has been at various times a good deal of trouble with the cut-out coils in the lamps burning out; this was pointed out to the German makers, and evidently more attention has been given to this point, as lately very little trouble in this direction has been experienced. It is the author's general experience that wet weather exercises a deleterious effect on the burners, which have to be replaced much oftener during a spell of wet weather than during an equal period of fine weather. The average illumination results obtained from a ½-ampere "A" type burner with a well-designed reflector compare very favorably with results taken by the author from a single gas mantle in good average condition throughout the town. Experiments were also made with the "Luna" type of lamp, but owing to the position of the burner the distribution of light is not in the author's opinion at all satisfactory or suitable for street lighting; no arrangement of reflectors that he has, up to the present, been able to devise has got over the fact that the larger proportion of the light is thrown vertically downwards. To sum up the author's experience with Nernst lamps in a few words, the greatest fault he has to find with them is their want of uniformity. This is most apparent in the life of the burners, as, although the average life obtained in Maidstone is 676 hours, yet they have had many burners in use for over 1000 hours, and several between 2000 and 3000, equally they have had many which have failed before they have reached 100 hours burning. This want of uniformity is also noticeable in the way in which the candle-power falls off, some burners do not appreciably drop for quite a long life, while others lose a great deal of their light-giving properties in a very short time, and will then last in this condition for a long while. The author then considers the three problems which confront the station engineer before he can get the street lighting into his own hands. To give a light at least equal to that given by the ordinary gas mantle: A ½-ampere "A" type lamp at 230 volts will give a degree of illumination superior to that given by a gas mantle, both when measured by an illumination photometer in the streets, and, what is far more important, when judged by the eye of the general public. This point having been settled, there remain the two more important ones, namely, that the cost shall not be greatly in excess of the cost of gas lighting, and that the electricity supply works shall get a profit out of the business. As a result of a great many inquiries the author finds that the annual cost per post for a gas lamp having a single mantle varies from $15 to $20 as a general rule, which price is inclusive of trimming and maintenance charges; and he thinks $17.50 an average figure. These gas lamps are generally placed at distances apart varying from 40 yds. to 50 yds., thus the cost of lighting a mile of street will vary from $612.50 to $770 accordingly. An equally illuminated street can be got by means of ½-ampere Nernst lamps placed at a distance of 55 yds., although in Maidstone, as the existing gas columns are used, they average 50 yds., and the author hopes to be able to show that a ½-ampere lamp can be kept alight from dusk till dawn for $17.50 per annum. The lamp having a 220-volt burner and a 20-volt resistance on a 230-volt circuit requires 390 Board of Trade units during the year, and has actually cost $2.25 for renewals of burners, resistances, etc., $2.50 for lighting and extinguishing and cleaning; interest and sinking fund charges, calculated at 6 per cent on $30, absorb $1.80, repairs and maintenance of fuses, etc., have actually cost 70c. per annum, thus leaving $10.25 for the 390 units of electricity consumed.

Current Limiter—*L'Electricien* contains an illustrated description of overload relay, the purpose of which is to control the action of a fuse. The device, which is shown diagrammatically by Fig. 6 herewith, consists of a wire through which the current to be controlled passes, and the expansion of which when heated allows it to be drawn to

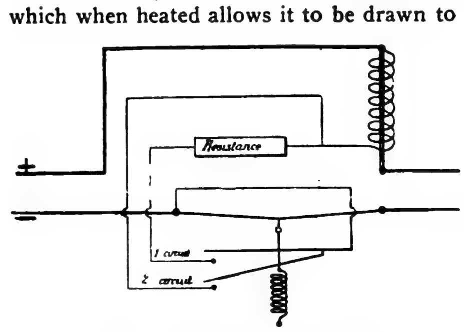


FIG. 6.—CURRENT LIMITER.

one side by a spring. When moved to the side the wire closes two contacts, one after the other. As shown in the diagram, a heating coil is placed around the fuse which carries the whole current in the usual way,

but is capable of withstanding a considerable overload. When a slight overload is thrown upon the system the wire expands and a contact is closed which results in current being sent through the heating coil connected in series with the resistance. By this arrangement the fuse will be melted in about five minutes should the load exceed the normal by a few per cent. With an excessive overload the expansion of the hot wire is so great that the second contact is closed. This cuts out the resistance of the heating circuit and melts the fuse in thirty or forty seconds. When this result obtains the circuit is of course opened and the wire in cooling cuts out the heating circuit. The device may be used on either alternating or direct-current circuits.

Statter Time-Limit Device.— The London *Electrician* describes the novel, yet simple, time-limit device shown by Fig. 7 herewith. It consists of a cylindrical plunger which is drawn up vertically into a solenoid when the current in the latter exceeds a predetermined amount. In order, however, to prevent the plunger from responding at once to the pull, a flat brass

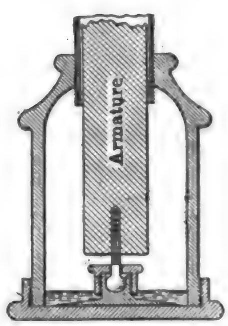


FIG. 7.—TIME LIMIT DEVICE.

disc is fixed at its lower end, the disc lying flat against the bottom of the receptacle which encloses the whole mechanism. The bottom of the receptacle is covered with a layer of oil or glycerine, and the plunger cannot rise immediately when an overload occurs owing to the "suction" effect. It rises ultimately, and the time it takes to overcome the suction effect depends on the pull. The receptacle referred to can be screwed up or down, so that the relative position of the plunger and solenoid may be speedily altered. This, of course, serves to adjust the current strength at which the device will begin to act.

Load Factor..—The London *Electrician* gives an abstract of a paper read at the tenth annual convention of the Incorporated Municipal Electrical Association by A. Sinclair, on the load-factor and its effect upon a central station. The author thinks it plain from his remarks that it is essential to the cheap generation of electricity to increase the load-factor of a station by every possible means. He would advise first, the increasing of the ordinary lighting load by systematic canvassing, thereby bringing before the notice of probable consumers, in an attractive form, by booklet or otherwise, the great advantages of electric lighting over other forms of illumination; lighting is mentioned because, although an increased lighting load does not materially decrease the cost per unit, still the larger the output the better it is for the general welfare of the undertaking. Secondly, public lighting should be extensively used, for by its use the financial position is so improved as to allow energy to be sold at cheaper prices; Edinburgh and Glasgow may be cited as typical examples of the fruitfulness of this supply. He also is of opinion that this point does not always receive its due consideration, and where it is tried, more or less extensively, its progress is often throttled by the charge per unit being too high, thus affording adverse comparison with other forms of street illumination. Thirdly, and on this point he lays particular stress, that great hopes may be held for the future of stations by dispensing power on a large scale to small users at cheap rates. Where powers are held for the hiring out of motors, this class of consumer is making great headway because many view with much apprehension the scrapping of their present plant and substituting electricity with what they think the possibility of failure. When they know that by hiring a motor their liability—should they wish it—ends with the year, they are more prone to enter into a trial in what they consider to be more or less an experiment. The experience in this direction in Swansea has been to add very largely to the business, and to some extent to account for its successful running; in two years they have improved their load-factor from 12 to nearly 18 per cent. With regard to traction he says not many stations are fortunate to have this valuable asset, but the experience of those having such a load is quite sufficient to demonstrate its help in producing excellent results. Another feature touched upon was his belief that electricity cannot be purveyed; a uniform price per unit cannot be fixed, but must depend on the nature of the supply—*i. e.*, quantity and load-factor. The maximum demand system meets the requirements of the case, but, unfortunately, its explanation is so complicated to the ordinary individual that he either cannot or will not try to understand it. The author suggests that if a system simple in itself could be arrived at whereby a customer's load-factor could be readily and easily ascertained, his charge per unit could then be regulated by a discount on its price. By some such means the ordinary customer, usually a man of business, would be appealed to because he would readily accept the situation if he is aware that his account is subject to a discount on the quantity of energy he uses, whereas when confronted with the complex explanations of the maximum demand, he is amazed —always confused—and if his bill be high, never satisfied.

Some Recent Electrical Patents

Multiple-Switch Motor Starter.—Motor starters comprising a series of switches arranged to be thrown in successively and thereby cut out sections of a starting resistance are familiar to every one concerned. One of the later developments along this line is represented diagrammatically by Fig. 1 and has been patented by Mr. Frederick Mackintosh, of Schenectady, N. Y. The apparatus includes an overload circuit-breaker, 4, of the usual type, a no-voltage circuit-breaker, 11, and the multiple-switch starter. When the no-voltage switch is closed it sets a multiple latch in the paths of detents on the starting switch levers, 18, this latch serving to hold the switches in after they have been closed by hand and to release them all when the no-voltage

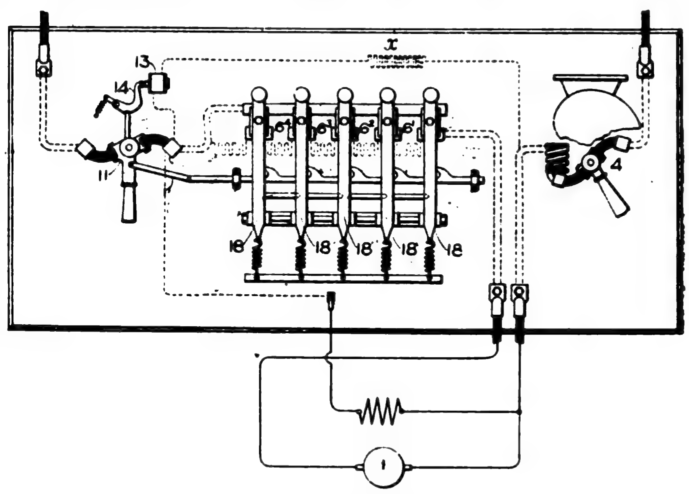


FIG. 1.—MULTIPLE SWITCH MOTOR STARTER.

switch opens. The no-voltage switch is held closed by the dog, 14, which is in turn held by the release magnet, 13, connected across the motor terminals in series with a resistance, *x*. If the current supply should fail or if the overload circuit-breaker, 4, should open, the release magnet will, of course, be de-energized and allow the spring to pull away the dog, 14, releasing the switch, 11; this switch will be opened by a spring (not shown) and release the individual starting switches, 18. The connections of these are of the familiar plan. Patent No. 793,454.

Carbon Resistance Rods.—It is desirable in the application of "stationary" lightning arresters to provide a high resistance in series with the discharge gap in order to limit the flow of generator current after the arc has been established by the lightning discharge. In practice difficulty has been found in obtaining a suitable material of which to make this resistance. According to a patent recently issued to Mr. Willis R. Whitney, of Boston, Mass., he proposes to use a mixture of carbon dust and some binding material, such as ordinary clay,

and to employ novel means for making rods of this mixture which shall have uniform resistance. The inventor states that the lack of uniformity hitherto obtained was due to a surface coating of carbon, and that when this is removed, even to a depth of only a few thousandths of an inch, the conductivity of the rod is greatly decreased, and rods of the same size and shape have almost uniform resistances. The removal of the surface coating, he states, is conveniently effected by exposing the rods to intense heat in the presence of air. Patent No. 792,638.

Motor Controller.—In the construction of speed-controlling rheostats for electric motors it is customary to equip the apparatus with a spring to return the regulating arm to the "off" position when the latter is released, and a detent of some sort adapted to hold the arm in any position at which it may be set, the detent being usually released electromagnetically. A combined speed-regulating rheostat and motor starter of this general type has been devised and patented by Mr. W. C. Yates, of Schenectady, N. Y., the essential features of which are shown by Fig. 2. The detent for the controlling arm consists of a brake band, 13, around a drum, 12, the drum being mounted on the same spindle with the arm and the band being controlled by an electromagnet, 19. The device further embodies the feature of separate starting and regulating contacts, the brake remaining entirely relaxed while the arm is passing over the starting contacts, 4. This is effected by the method of connecting up the brake magnet; so long as the arm is within the range of the contact strip, 7, the field winding, 25, of the motor is connected directly across the circuit, but when the arm passes to the button, 8, the brake magnet is inserted in series with the field winding. The starting resistance, 5, is in the armature circuit, as usual, while the speed-regulating resistance, 9, is in the field circuit. When the starting resistance has been all cut out the magnet and brake come into action and hold the arm in any position beyond; upon the failure of the supply current the magnet releases the brake, of course, and the arm is drawn to the "off" position by a spring in the ordinary manner. Patent No. 793,494.

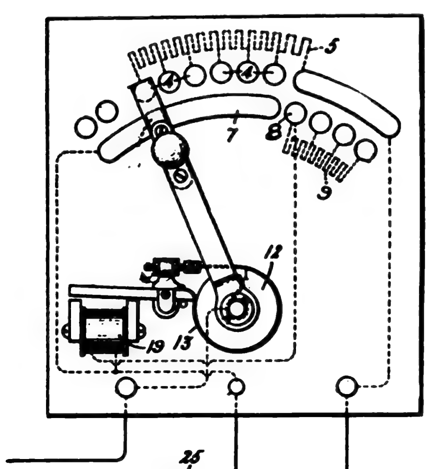


FIG. 2.—MOTOR CONTROLLER.

CENTRAL STATION ENGINEERS.

X.

G. W. Brine.

G. W. Brine was born in Cambridge, Mass., on Sept. 9, 1867. He graduated from the Winchester High School in 1884 and made his entree into the electric light field as assistant bookkeeper in the office of the southern district of the Edison General Electric Company, the headquarters of which were located in Atlanta, Ga. He retained this position until the district was abolished, shortly before the consolidation of the Edison General Electric Company and the Thomson-Houston Electric Company, when he accepted a position in the New York office of the General Electric Company, afterward being transferred to the Boston office. He returned to Atlanta. Ga., in August, 1892, accepting the position of auditor of the southern office of the General Electric Company. He remained with this company until 1894, and on January 15 of that year he accepted a position as cashier of the Georgia Electric Light Company. His steady application to the interests of the company resulted in his being promoted to secretary-treasurer and manager, which position he held until the consolidation of all the railway and lighting companies in the city of Atlanta, in April, 1902. He was then made vice-president and treasurer and manager of the electric department of the Georgia Railway & Electric Company, into which company all the other companies were merged.


G. W. BRINE.

THE LIGHTING SITUATION IN SPRINGFIELD, OHIO.

To the Editor, American Electrician:

We noticed a statement in your June number, in the department of Central Station News, concerning the situation in the electric light business in Springfield, Ohio. This item stated that the People's Light, Heat & Power Company had bought up all of the electric light plants and merged them into one, thereby giving them a monopoly of the business in this city. We wish to correct this statement, as The Home Lighting, Power & Heating Co. has been established in this city for five years and furnishes at the present time 75 per cent of the commercial lighting of the city. It is now putting in a complete steam heating system for heating the public and private buildings of Springfield, and has just purchased 1000 horse-power more in boilers and a 500-kw., three-phase Westinghouse turbine-generator, which in addition to our 110-volt machines, gives us 1000 kilowatts of generators, besides a 300-kw. motor-generator.

As we are in the business to stay in this city, and are furnishing a great amount of the private lighting, we think your statement does us an injustice; The People's Light, Heat & Power Co. certainly has not a monopoly of the business here. A correction in the August issue would be no more than justice to ourselves, and we would appreciate it.

Springfield, Ohio. W. N. ZURFLUH.

[We take much pleasure in giving space to the above correction of the statement to which Mr. Zurfluh refers. It was made in good faith, of course, on what we considered good authority, but it is manifestly impossible for us to verify news items of this character before publication. We use all known precautions against misstatements, but it is impracticable to prevent them absolutely, and when they occur we appreciate corrections of them.—EDITOR.]

NOTES.

New Incandescent Lamp.—A Frenchman named Canello has devised a new incandescent lamp having a filament formed of oxides of alkaline earths covered with a thin layer of metallic osmium.

The Colorado Electric Light, Power and Railway Association announces that its third annual convention will be held at Glenwood Springs, Colo., September 18 to 20 inclusive.

Machinery Wanted.—It is authentically reported that the Standard Electric Light, Heat & Power Company, of Avoca, Pa., is in the market for a direct-connected generating unit and a belted set, the generators to give two-phase alternating currents at 60 cycles.

Condolence in Order.—The city council of Ashland, Ore., recently passed an ordinance to install a municipal electric light and power plant to cost about $50,000.

United Engineering Building.—The committee in charge of the work on the United Engineering Building has awarded the contract for the erection of the structure; the contract price was $795,000 for the edifice alone. It is hoped that the building will be completed and furnished ready for occupancy by October, 1906.

Electricity and Red Noses.—A cable dispatch from Berlin says: "Prof. Lassar, a famous Berlin skin specialist, has found means to restore red noses to their normal color and uses. An instrument, shaped like a large tooth brush, with forty platinum wires instead of bristles, is used, and this is connected with an electrical machine. The treatment consists of hammering the lurid nose till it bleeds, when the treatment is stopped for a day. Two hammerings a week for some months suffice to eliminate the excessive redness." It is not stated how much hammering is required to eliminate the nose entirely.

"Successful" Municipal Plant Operation.—A daily New England paper has someone on its staff who is not devoid of technical intelligence. In a recent issue it was stated that "Marblehead appears to have been the most successful of the towns operating their own (lighting) plants, for its net loss amounts to only $1500, while that of Danvers amounts to $4000, and Peabody's is $9000." If the writer had gone farther afield he might have congratulated Marblehead more enthusiastically, if not violently, upon finding that at Greenfield, Ind., where the city owns and operates the electric light plant and water works, more than $17,000 is required for making repairs and improvements on the light plant, while the city not only has no money available, but is in debt up to the legal limit.

Street Railway Conventions.—The annual convention of the Street Railway Accountants' Association of America will be held in Philadelphia, Pa., September 28, 29 and 30, with headquarters at the Hotel Walton. The Mechanical and Claim Agents' Association will meet on Monday and Tuesday, September 25 and 26. The American Street Railway Association will meet on Wednesday and Thursday, September 27 and 28. The annual convention of the American Street Railway Association will be held in Philadelphia, Pa., September 25 and 30. A pavilion of the Philadelphia Museum and an adjoining building will be used for exhibition purposes. The Pennsylvania Railroad has a switch track entering the building, which has about 500 feet of track under cover. Outside of the buildings there is space for outdoor exhibits and two railroad tracks.

Electrical Contractors' Convention.—The National Association of Electrical Contractors held its annual convention in Boston the week beginning Wednesday, July 19. The convention was accompanied by a large exhibition in Mechanics Building, where also the sessions were held. As the proceedings are conducted with closed doors and the convention is in session at this writing there is nothing of interest to report as to what was done. The intense heat has interfered with a very large attendance, but there were 173 delegates registered and 263 guests—supply men, exhibitors, etc. The New York contingent arrived on a special train under the conduct of Mr. Alex. Henderson, master of transportation, some thirty being on board and a very pleasant trip being made. The dinner of the association was given on Wednesday night, but the attendance was limited to members of the association only. On Thursday the association and registered guests went on a trip to Nantasket Beach by boat and dined at Wade's Nantasket Point Hotel.

Ontario Power Company Begins Operations—On July 1 the Ontario Power Co., of Niagara Falls, for the first time applied potential to its 60,000-volt transmission line. Work was begun upon this development of 200,000 electrical horse-power in March, 1902, over three years ago. On June 15 water was admitted to the intake works, now completed for the full capacity, and on June 22 the first 10,000-h.p. unit, generating three-phase, 25-cycle current at 12,000 volts, was put in motion. The first set of step-up transformers to raise the potential from 12,000 to 60,000 volts, each of 2500 kilowatts capacity, oil-insulated and water-cooled, was put in service on July 1. The permanent transmission line, at present only partially completed, consists of duplicate lines of 49-ft. tripartite steel towers, carrying porcelain insulators of a new type on iron pins, and aluminum cables nearly an inch in diameter. The average length of span is 550 feet. The present expectation is to have three units, with a total capacity of 30,000 horse-power, delivering power by the last of September.

Wages for Beginners.—The General Electric Company, which is looking for apprentices at its West Lynn factory, in response to inquiry, announces the following salaries: To graduates of high schools only—drawing office apprenticeship course, $5.33 per week for first six months, $6.30 per week for second six months, $7.28 per week for third six months, $8.25 per week for fourth six months, $9.22 per week for fifth six months, $10.67 per week for sixth six months. There will also be a bonus of $75 distributed if the three years of service have been satisfactory. Shop apprenticeship course, $4.48 per week for first six months, $5.60 per week for second six months, $5.72 per week for second year, $7.84 per week for third year, $9.24 per week for fourth year; bonus of $100 at expiration of term if services have been satisfactory. For high school students and grammar school graduates—shop apprenticeship course—$3.36 per week for first six months, $4.48 per week for second six months, $5.60 per week for second year, $7.00 per week for third year, $8.40 per week for fourth year; bonus of $100 at expiration of term if services are satisfactory.

Testing Rubber-Insulated Wire.—A conference was recently held at the rooms of the National Board of Fire Underwriters for the purpose of devising ways and means for testing all rubber-insulated wire manufactured under the rules of the National Board of Fire Underwriters and to prevent the introduction into commercial use of any wire which proves inferior to the standard demanded by the National Board. Reliable manufacturers would then be protected against unfair competition and the use of wire with defective rubber insulation would be practically prevented. A committee consisting of six members to form the Wire Inspection Bureau was chosen at this meeting. This bureau will draw specifications for testing rubber-insulated wire manufactured under the rules of the National Board, decide on such tests and when and how they are to be made. The bureau will also appoint the necessary electrical inspectors, three being considered sufficient at present, who shall from time to time visit the testing laboratories of any factories making rubber-insulated wire and supervise, make and verify tests specified by the bureau. The necessary expenses will be raised by issuing stamps and selling these to the different manufacturers at a charge of one cent per 100 ft. of wire tested. These stamps will be attached to the coils of tested wire by the manufacturers themselves and serve as a guarantee that wire so stamped has successfully withstood the tests specified by the bureau. The majority of the rubber-covered wire manufacturers have agreed that on and after October 1, 1905, all National Code wire manufactured by them will be made up under the new specifications and duly tested, and will also bear the identification mark of the Wire Inspection Bureau. It is understood that a reasonable time will be allowed after this date for the disposal of code wire, manufactured before October 1, not bearing the stamp, and with this understanding the October list of electrical fittings will contain the names of all rubber-covered wire manufacturers agreeing to the tests and to the use of identification stamps. The Wire Inspection Bureau will supply identification stamps for 250-ft., 500-ft. and 1000-ft. coils. No wire will be considered as having been tested which does not have an identification stamp. The stamp will be on linen paper and will be fastened to the shipping tag attached to wire coils. They will be provided with serial numbers and on coils of less than the above specified lengths a credit for excess in stamp value may be obtained from the Inspection Bureau. The stamps are to be cancelled by the manufacturer when used, the date of manufacture of wire also being plainly shown. The Wire Inspection Bureau specification giving factory tests, which will be required on all wire having approved stamps, will be issued shortly.

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CONTENTS.

A Progressive Central Station Idea.

An interesting piece of central station advertising is now being carried out in Cambridge, Mass. The Cambridge Electric Light Company recently completed a new plant on Western Avenue, bordering the Charles River Parkway, and visitors are encouraged to visit and inspect the station, as in the case in many other places where interesting plants have been installed. When anyone applies at the company's office for a pass through the station, he is handed a neat pamphlet which is an illustrated guide to the plant and enables the visitor to go through with his eyes open to the purpose and meaning of the equipment. The pamphlet describes in very concise but clear phraseology all of the machinery and apparatus, from the coal-conveying cars to the lightning arresters, explaining the several conversions of energy along the way. The booklet is illustrated with excellent reproductions of photographs, and at the end is an inset showing the view from the top of the chimney, which is 255 ft. high. The Boston Edison Company has also distributed pamphlets descriptive of its system and stations, these being ordinarily found at the company's permanent Head Place exhibit. The idea is an excellent one.

Ventilation in Isolated Plants.

Although the engine and boiler rooms of most isolated plants installed in restricted locations necessarily inflict considerable discomfort on the operating shifts in hot weather, much can be done to relieve the situation by the judicious employment of fan motors. In fact it is difficult to suggest a better way in which the owner of such a plant can spend a little money for the comfort of his employees than to purchase a few small electric fans for use in the hot corners of the premises. For many reasons the tenants of modern office buildings have been growing more and more dependent upon the fan-motor to carry them through the rigors of the hot summer, so that it would be trite to argue the importance of such equipment as a necessity instead of a luxury; the fact is almost universally appreciated. The point is, however, that the use of the fan-motor in the engine and boiler room has not as yet been pushed to anything like the degree that it reasonably might be.

What is needed in practically every case is a complete change of air in continuous and steady progression; for which purpose there must be an appropriate inlet and outlet. Little is gained by simply stirring up the air over and over again by operating a single fan-motor in one corner of a practically shut-in room. The proper design of a modern isolated plant should naturally include the provision of adequate ventilating facilities, but where such work has not been done it is seldom a difficult matter to rig up at least a temporary series of ducts for use while the warmest weather lasts, and if the matter is intelligently handled the results ought to be thoroughly satisfactory. In the boiler room the main point is to bring cool fresh air from out of doors; the fires will generally dispose of the outlet problem, although an exhaust fan in the upper part of the room is sometimes a great help. Both inlet and outlet facilities need careful planning in the engine room, and throughout the entire plant an important point is not to neglect the condition of the pipe covering. The cost of operating even half a dozen fan-motors continuously is so small that it is worth trying in every case where the ventilation problem presses.

Power Plant Design.

Although one of the most interesting things about power plant design is the variety of treatment possible under different conditions, there is no doubt that such work is often carried too far away from the fundamental features of practice which nearly two decades of experience have shown to be desirable. It is not so much a question of special or standard apparatus as it is a matter of arrangement. In almost every power plant which we visit, notable differences in design are immediately apparent in comparison with previous installations, and while this is to a certain extent natural and desirable, it is frequently impossible to escape the conviction that the designers failed to appreciate the lessons of previous work.

For example, in two recent office building plants the power and lighting loads are distributed from the same and only set of bus-bars, and it is not too much to say that the result is a disgrace to modern engineering. Years ago it was shown that where the power load is heavy in proportion to the lighting output, incandescent lamps do not operate smoothly on the same circuit that supplies electric elevators; unless a storage battery is installed to take up the elevator current fluctuations, there is small hope of good regulation at the lamps. Every time the elevators start, the lights are certain to dim badly; in one "modern" plant the potential across the bus-bars was found to vary between 105 and 120 volts whenever

the motors drew current ranging from 50 to 500 amperes.

Quite apart from the question of lamp depreciation stands the more important matter of giving good service to the tenants. Attractive as the modern office building may be in comparison with the older business structures now, so rapidly being abandoned by progressive firms and houses, it cannot expect to hold its own in the close competition of these days unless its electrical and mechanical service is up to the best standards of the art. It is very poor policy to spend many thousands of dollars upon vestibule and corridor decorations and then supply the tenants with inferior elevator service, poor ventilation and unsteady illumination. It is far better to spend enough money on the power plant to provide separate machines for elevator and lighting service; or, if this cannot be done, to install a storage battery or get the manufacturers to advise what other correction is practicable. One way out of the trouble is to supply the lights from the local central station mains, leaving the motors to be supplied from the isolated plant bus-bars. All methods, however, are more or less expensive, and of the nature of makeshifts, except the fundamental plan of entirely separating the lighting and power circuits. If this is provided for in the original design, no trouble can occur, and the excellence of the service and operating economy are certain to justify an additional first cost of the installation.

Electricity in the Hospital.

Few persons whose attention has not been drawn to the matter realize the extent to which the modern hospital depends upon the electrical engineer for its comfort and convenience. As everywhere else, the cleanliness and flexibility of electrical equipment peculiarly adapt it to the exacting demands of organizations for the relief of physical ills. There is the question of ventilation, for instance. In the winter an even temperature is of great importance in hospital wards. An automatic system of electric heat regulation holds the thermometer within two or three degrees of standstill. In the summer the electric fan changes the air with high efficiency, and its noiseless operation is a great boon to the sufferers. From 3000 to 5000 cubic feet of fresh air per patient per hour are required in general hospital service, and the electric motor meets the situation with perfect success. Distributed ventilation is best secured through the flexibility of electrical equipment. Then there is the autopsy table, formerly associated with unpleasant odors. By placing a motor of about ½ horse-power beneath the table direct connected to a 24-in. exhaust fan delivering into a suitable duct, downward ventilation of the table is secured, with the most satisfactory results in the way of freedom from disagreeable air. In the same way the operating room offers excellent opportunity for the extraction of ether fumes and other contamination of the atmosphere.

The advantages enjoyed by the use of electric fans in hotel kitchens and laundries are available in the culinary and washing departments of the hospital. Electrically driven dish washers, extractors, mangles and ironing machines, and electrically heated flatirons, bosom, collar, cuff and neck ironers, all find a sphere of usefulness in hospital and sanatorium service. In the Agnes Memorial Sanatorium at Denver, but twenty minutes are required to dry work in the electrically ventilated laundry drying-room, in comparison with two hours by the older methods. For certain classes of work the electric heaters used in cooking are admirably adapted to hospital requirements. The localization and concentration of heat exactly where it is needed and without the annoyance of dust, dirt, smoke, ashes and cinders, are cardinal points of advantage. The electric heating pad of soft lamb's wool, with its even temperature, is immeasurably superior to the leaky, heavy and gradually cooling rubber hot-water bottle.

Almost every important hospital is now equipped with X-ray apparatus, medical induction coils, small incandescent lamps and mirrors for surgical work; cautery appliances, cataphoresis batteries, etc. In some cases small motors are used to operate tiny circular saws designed for bone cutting in delicate operations. To name all the appliances of surgery and medicine in which electricity plays a part would require the space of a catalogue. The list of electric lamps useful in hospital service covers many different types, ranging from the 8-c.p. or 16-c.p. lamp employed in ward and private room lighting to the smallest exploring lamp available for physical examinations. Some of the public waiting rooms and certain of the offices and corridors require even larger illuminating units, such as the Meridian or Nernst lamps, for the proper solution of the lighting problem. It would be difficult to cite any other case of lighting practice where the atmospheric purity of electric illumination is more important than it is in the hospital. Turning to the smaller applications, the electric annunciator, small buzzer and interior telephones have outlawed the crude and noisy speaking tube, and in the private fire alarm system we have but another evidence of the part which electricity plays in the splendid work of life and property saving.

Finally, the small motor has many other uses in the hospital besides the driving of ventilating fans. Many hospitals are equipped with small carpenter and machine shops, private laboratories, air compressors for cleaning, pumps, ice-making machinery, and refrigerating apparatus of great variety. Here the electric motor applies with the same and high degree of satisfaction that has attended its use in other classes of work. The cost of attendance may be cut down—and in few cases is the cost of labor proportionately higher than in a hospital. A hospital lighting and power load is well worth obtaining by the progressive central station man, and as time goes on the usefulness of electricity in this field will doubtless be more and more recognized.

Our "How-to-Make" Articles.

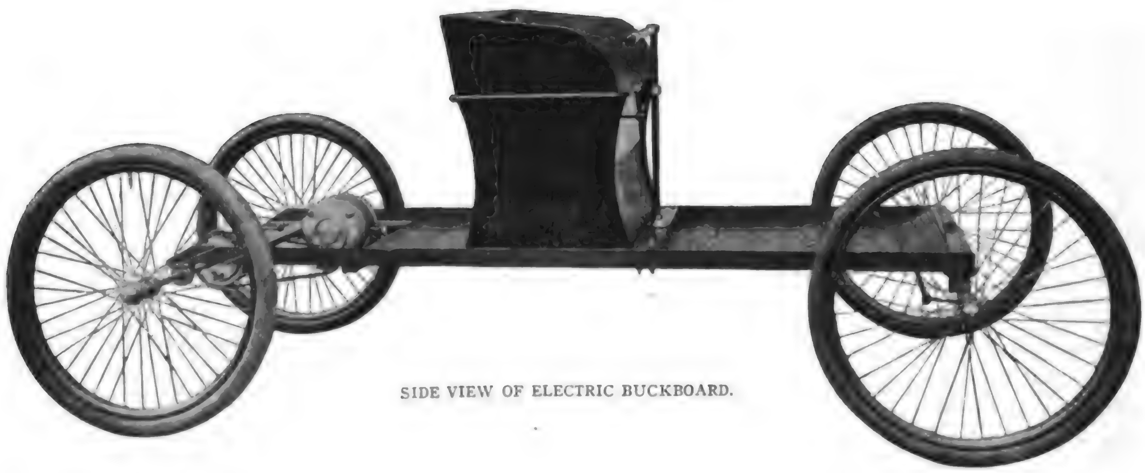
As all regular readers know, one of the chief features of this journal is the article which follows immediately after this page of each number of the paper. This article gives instructions for the design or construction (or both) of some piece of machinery or apparatus, and we receive a gratifying number of letters each month concerning the "how-to-make" article in a previous number. Many of these, however, ask for information as to where the apparatus can be bought outright, ready for service, and we take this opportunity to inform all readers that we do not publish detailed descriptions of apparatus that is already on the market. The object of the articles referred to is to enable readers to build the apparatus or machinery, not to buy it. Upon consideration it should be clear that the publication of instructions for making apparatus or instruments that have been regularly put on the market by manufacturing establishments could scarcely be considered fair to the manufacturers. In many cases, patterns and rough or partly finished parts of the machines or apparatus described in our articles may be obtained from some model-making establishment, and in a few cases, such establishments have taken up the manufacture of the apparatus after it has been described in our columns; but we never under any circumstances publish manufacturing descriptions of commercial instruments, machines or devices.

HOW TO MAKE AN ELECTRIC BUCKBOARD.

BY J. C. BROCKSMITH.

The Battery and Controller.

The builder may have his choice of any of several good makes of storage batteries which can be used in this machine. The battery compartment is of suitable size to contain 16 cells E 18 Edison battery; also an Exide battery of 16 P V 5 cells can be accommodated.



SIDE VIEW OF ELECTRIC BUCKBOARD.

In case the Edison battery is used, the motor would have to be wound for 20 volts, and in the case of the Exide battery the winding would be for 32 volts. Just what the winding will be for any voltage can be easily deduced from the figures already given by remembering that a reduction in the voltage of one-half would mean an increase in the cross-section of both field and armature wire to double the previous value, or an increase in the size of three gauge numbers. In this way any winding may be computed by simple proportion.

For the benefit of those who wish to construct their own battery, one used by the writer with good results will be described. The battery is of the lead type with pasted plates, the paste being applied to grids cast from an alloy of lead and antimony, containing 12 per cent of the latter metal.

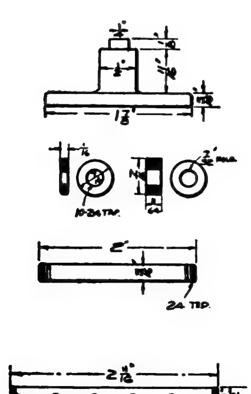


FIG. 22.—SECTION OF GRID AND DETAILS OF RODS, WASHERS, ETC.

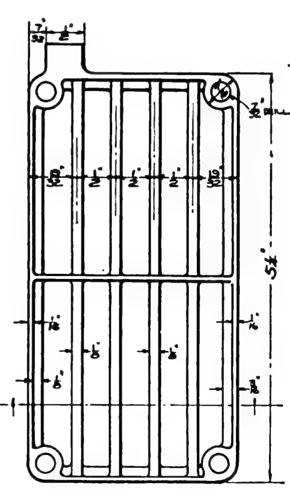


FIG. 21.—DETAILS OF GRID.

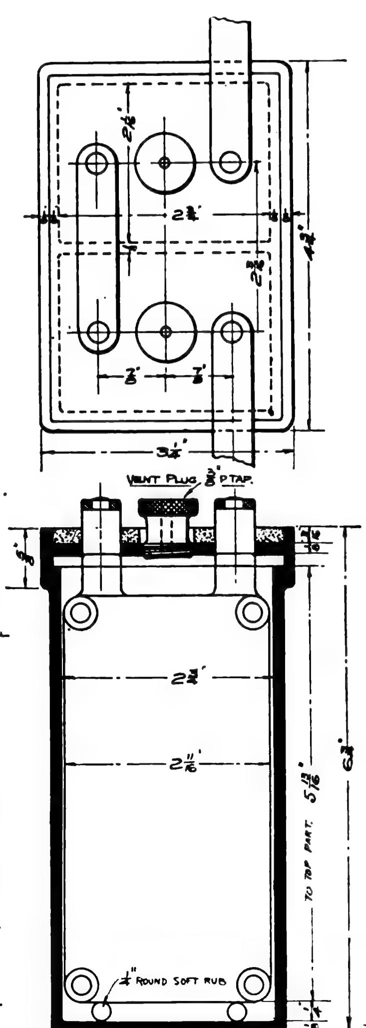


FIG. 20.—SECTION AND TOP VIEW OF COMPLETE DOUBLE CELL.

Fig. 20 illustrates the complete double-cell unit. A rubber jar is used which has a partition in the center; each compartment contains a five plate element consisting of 2 positives and 3 negatives, the end negatives being only one-half the thickness of the other plates. The weight of each element alone is 3¼ pounds, and the weight of the complete double cell with solution is 8½ pounds.

Fig. 21 is a detail of the grid used for both positives and negatives. It consists of a light rectangular frame having sides of T-shaped section and provided at the corners with bosses for the binding rods to pass through. The frame serves to give a definite form and thickness to the mass of active material, and the current is conducted to and from the mass by means of the vertical rods which are imbedded in the active material.

A lug is provided at the top of the grid for making connections with the finished plate.

The material which is applied to the positives consists of minium or red lead with a slight admixture of litharge. This is moistened with a solution of ammonium sulphate, and while in a plastic condition the grid is filled until the material stands a trifle above the edges of the frame. The grid and contents are then subjected to a strong pressure between some layers of blotting paper in a suitable press, which removes the excess moisture and compacts the material so that it now is flush with the edges of the frame.

The negative grids are treated much the same as the positives, except that in this case the material consists of litharge with a slight addition of red lead, and the whole is moistened with dilute sulphuric acid.

After the plates have been prepared in this manner and have been allowed to become dry and hard, they are assembled in the form of elements by means of the hard rubber rods and washers shown in detail in Fig. 22. It is not necessary to use pure hard rubber for this purpose; some of the cheaper compositions will answer just as well. The washers can be most conveniently cut from a tube of suitable diameter. In addition to the rods and washers some perforated and corrugated separators are slipped between the plates as additional precaution against short-circuits.

When the plates are properly assembled the plates of the same polarity are connected together by soldering on the pillar connecting pieces shown in detail in Fig. 22. These are cast of lead-antimony the same as the grids; in order to protect the terminals from being acted on by the electrolyte, they should be dipped in acid-proof paint after being soldered on.

The elements are now placed in their jars and connected in series and formed by passing a current in one direction through them, preferably continuously, until all the material on the positives has been converted into peroxide, by which time

the negatives will also have been reduced to spongy lead. The state of formation is best determined by the appearance and color of the plates, which should be a deep brown, almost black, when wet, for the positives and a dark slate color for the negatives; the color, of course, should be uniform all over the plate.

REAR VIEW OF ELECTRIC BUCKBOARD.

During the process of forming, the electrolyte used should be of much lower strength (about 1100 sp. gr.) than the regular used during working the cell, in order to avoid as far as possible sulphating the material, which would delay the formation. When fully formed the forming solution may be turned out, the plates washed, and replaced in the regular electrolyte of 1250 sp. gr., which must be mixed and allowed to cool before being placed in the jars.

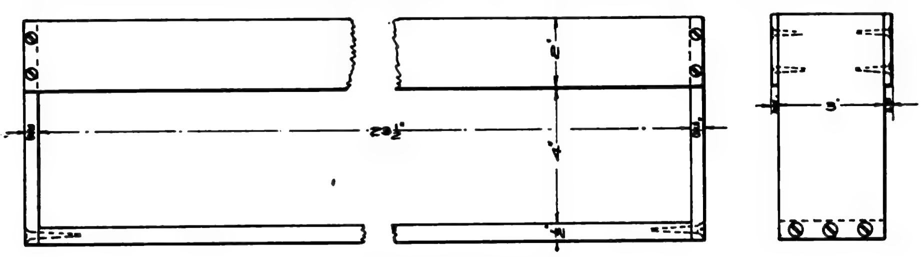


FIG. 23.—BATTERY TRAY.

Each cell may now be sealed by pouring in on top of the cover a layer of sealing compound, which is heated until quite fluid and will then adhere firmly to the sides of the jar, rendering it acid tight.

In order to combine the cells in convenient units for handling and connecting to the controller some wooden trays are necessary, which are shown in Fig. 23. Four such trays are used, each containing five double cells. The trays are best made of cherry and should be well painted with P. & B. or acid-proof paint.

In the operation of the vehicle the cells should not be discharged below 1.75 volts per cell or 70 volts for the entire battery in series. In charging a high rate can be used at first, if the cells were completely discharged; this should be gradually reduced, as the charge comes up, until the battery shows about 102 or 103 volts, with a current of 3 amperes flowing, when they may be considered fully charged.

The battery should be gone over occasionally and the condition of each individual cell determined to see that the electrolyte is of the proper strength and completely covers the plates, and that the voltage is right and there are no weak cells.

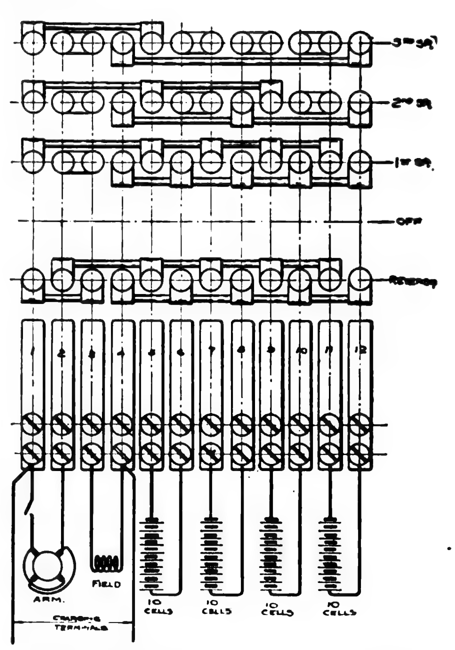


FIG. 25.—DIAGRAM OF CONTROLLER CONNECTIONS.

About once in six weeks is often enough for this inspection if the vehicle is used moderately often.

Fig. 24 shows a sectional plan and elevation of the controller. It is of very simple construction, consisting of a hard wood cylinder 2 inches in diameter, which has four rows of brass screws, each row containing 12 screws. Upon this cylinder 12 flat springs of hard brass or bronze press and make contact with the successive rows of screws as the controller cylinder is moved from one position to another. There are five positions of the cylinder, one of which, however, has no contacts engaged, this being the "off" position.

The frame of the controller is a casting, preferably of alzinc, consisting of a semi-circular top and bottom connected by a ribbed back piece all cast in one. Against the rib at the back of the frame is mounted a strip of fibre ¼ inch thick and 1 inch wide, which is tapped for screws that fasten the brass contact springs in position. Connections are also made to these same screws.

For convenience in making connections between the screw heads on the cylinder it has longitudinal grooves cut at each side of every row of buttons. Small clips of thin sheet copper are fastened under each screw head and soldered to bare copper wires laid in the grooves. The grooves are then filled in with plaster of Paris so that the cylinder presents a smooth surface. Ordinary round head brass machine screws are used for this purpose, and after all connections have been made the cylinder is mounted on its sleeve of steel tubing and placed in the lathe, and all the screw heads turned down to a uniform diameter, pro-

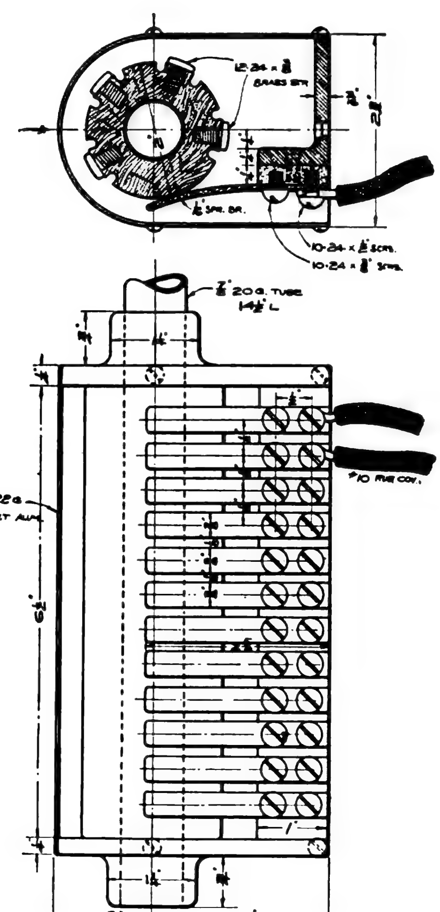


FIG. 24.—SECTIONAL PLAN AND ELEVATION OF CONTROLLER.

jecting about 1/16 inch above the surface of the cylinder.

Fig. 25 is a diagram of connections which is intended to serve as a guide in making the taps on the controller cylinder, and also in connecting the motor and battery leads to the contact springs.

On the first speed all the four battery sections are in multiple, giving 20 volts at the motor. On the second speed the battery is half in series and half in multiple, giving 40 volts at the motor, while on the last notch the cells are all in series, giving 80 volts on the motor and the highest speed. The reverse is just the same as the first forward speed, except that the armature leads are interchanged, thus reversing the direction of rotation.

The Woodwork.

This is of the simplest description; only straight boards are used. The curved surfaces usually seen on automobile bodies would probably be out of question for anyone wishing to construct the woodwork himself. On the other hand, the boards can be shaped on the edges with comparatively little extra labor, so as to make quite an attractive appearance. The shape of the seat panels and the dimensions for them are shown in Figs. 1 and 3. All of the woodwork is intended to be made of ash and looks very well when finished in the natural wood color by putting on two or three coats of orange shellac rubbed down with fine sand paper between each coat. This treatment brings out the natural grain of the wood and while it is simple and inexpensive still gives very good results.

The flooring also is composed of ash boards 6 inches wide and 24¾ inches long and ⅜ inch thick, laid on the lower flange of the angle frame, and fastened thereto by means of 10-24 x ½-inch flat head machine screws, 4 to each board. The flooring is shellacked the same as the other woodwork.

The tool compartment under the seat is provided with a hinged door, which opens from the back and closes with a small drawer lock. In this compartment should also be installed a single-pole, single-throw knife switch, placed in one of the motor armature leads. This is to be open while charging, and also when leaving the machine unattended it can be opened and the door of the compartment locked, when it will be impossible to run the machine without first unlocking the door.

The following is a list of stock required for the woodwork:

Wanted for.	Pieces.	Size.
Seat sides.	2	19x8x⅜
Seat back.	1	32x8x⅜
Seat panels.	2	16½x17½x½
Seat bottom.	1	32x18½x⅝
Front & back tool compt.	2	32x7x⅜
Seat fillets.	2	8x1¼x1¼
Front crosspiece.	1	24¾x2x1⅛
Middle crosspiece.	1	24¾x2½x1¾
Flooring.	12	24¾x6x⅜
Battery trays.	4	23½x3x½
Battery trays.	8	6½x3x⅜

Dressed all over, grain to run in direction of dimension appearing first in above list. Where boards are too wide to be made in one piece they may be "edged up" in two widths.

BOILER ROOM TROUBLE.

BY S. F. HENRY.

In the early part of this year the writer was called in to investigate the boiler-room conditions in a street railway plant in western Ohio. The boiler plant consisted of one 11 ft. x 18 ft., single-ended Scotch boiler with two corrugated Morrison suspension furnaces fitted with Jones under-feed stokers, and four 400-h.p. Cahall horizontal, water-tube boilers, also fitted with the Jones under-feed stoker. The stokers were fed from bins over the boilers, and forced draft was supplied by a large engine-driven fan, the throttle of which was controlled by the steam pressure.

When the writer reached the plant they had had unlimited trouble with tubes burning out on an average of from four to six a day, and it was almost impossible to run a boiler more than one or two days without cutting it out of line to put in some new tubes. As there was not a sufficient number of boilers, it was impossible to keep one out for repairs or cleaning, so when it became necessary to put in tubes the boiler was cut out of line just after the early morning peak, and had to be in line by three or four o'clock in the afternoon. Along with burned-out tubes, it was also found that the retorts of the stokers burned out at a very extravagant rate, owing to the constant shutting down, in which case small leaks in the draft dampers caused the "green" coal in the retorts to burn back and destroy them. When the first boiler was opened to put in new tubes the writer had numerous caps taken off the front headers, which revealed a pretty serious condition of the boilers. In most of the tubes the scale was from ¼ to ⅝ inch thick, and many of the tubes and nearly all the rear headers were completely stopped up, so that circulation through them could not exist. This condition, together with the extreme forcing necessary to keep up steam when the daily boiler was cut out for tubing, to a great extent accounted for the continuous burning out of tubes. The final reason develops one of the objections to the under-feed stoker, which is caused by the fire being localized on such a small area and the intense blast through the tuyeres, especially in a plant in which the engine driving the blower is governed by the steam pressure, for when the pressure gets low the fan speeds up, and the consequent blast on this limited area is almost enough to burn out even a perfectly clean tube. Another difficulty in this particular plant was that the tubes were located too close to the fires, further increasing the bad effect of the blast. How serious this is can be judged from the fact that while forcing for the peak of the load between five and seven o'clock calculation from the amount of coal burned in one furnace showed a fuel consumption of about 175 pounds of coal per square foot per hour.

These conditions, and water with about 90 grains of calcium and magnesium carbonate and sulphate in solution, which was taken from an artesian well, are those which confronted the writer when he took charge of the plant. Of course, it will be evident that the first thing to be done was to clean out all the boilers thoroughly, but the question was how to do it, as it was impossible to keep one boiler out of line because of insufficient boiler capacity when in that condition. The method adopted was as follows: Each time a boiler was cut out, while the boiler-makers were putting in the new tubes a second gang of men was put to work at "turbining" the two or three lower rows of tubes and cleaning off the soot from the outside of the tubes, the back connections and from behind the rear headers and mud drums. In this way, by increasing the heating surface and getting out all the buckled tubes, by the end of two weeks the boilers were in such shape that it was possible to run with only three of them, and the increased efficiency of the boilers and their improved condition greatly reduced the danger of a boiler being disabled within three days, and it was therefore decided to cut one boiler out for drilling.

The drilling was carried out by working a night and a day shift, which, though the tubes were so badly scaled, enabled the work to be done in three and a half days. While the tubes were being drilled a gang was put to work thoroughly cleaning out the front and back headers and the steam and mud drums, while two men were kept busy cleaning off the hand-hole plates. Everything did not go as well as hoped for, and on the second day a tube gave out in one of the other boilers, but a little care in firing carried it through until after the evening peak. It was then shut down and a tube put in, and it was ready for the morning load, though all the other boilers were leaking very severely by the time the clean boiler was cut in again.

After the cleaned boiler was put in line there was no difficulty in keeping up the pressure with two boilers, and from then on the task of cleaning the others was comparatively simple, though considerable difficulty was experienced on account of leaky tubes in the cleaned boiler, since many of the tubes were very thin and started to leak soon after the boiler was cut into line. This was overcome, however, by cutting out the cleaned boiler after the evening load and retubing it at night, carrying the heating load (the only load between 1 a.m. and 5.30 a.m.) with the other two boilers.

A simple expedient which contributed much to the successful completion of the boiler cleaning was the coating of the inside of all the new tubes with graphite and oil, which, although it did not entirely prevent the formation of scale, very materially reduced it; furthermore, the scale which did form did not stick to the tubes and consequently was easily removed. The graphite was almost perfectly intact after removing the scale and was good for another run.

When the writer arrived at the plant the firemen were in the habit of allowing the automatics on the stokers to crowd in a lot of coal, let it burn down and then crowd in another load, and so on, resulting in excessive smoke and loss of economy; it also resulted in burning out tubes and retorts.

for in letting the fires burn down the blast on the tubes was more destructive, and the fires getting low caused them to burn in the retorts. No little difficulty was experienced in making the firemen stoke regularly, making the automatics work constantly, adjusting their speed to correspond to the load, and turning the clinkers over on the side plates before drawing them out. They would also let the fires get too thin after cleaning, and as two stokers were run by one automatic and both stokers would not feed at the same rate, one fire was generally too thick. This was overcome by making the men feed by hand after cleaning and adjust the automatics for the stokers which

BURNT TUBES.

Cause.—Scale, concentrated fire, tube too low, thin fire, soot and water in back connection, action of the "blow" of one tube on the next, irregular expansion and contraction owing to scale and soot which cause the buckling of tubes.

Remedy.—Clean tubes, carry heavier fire, do not let steam pressure become too low, clean the outside of tubes, clean out back connection once a week, keep dirt from behind headers so as not to prevent free expansion.

BURNT RETORTS.

Cause.—Low fires, leaks in draft pipes causing green coal to burn back, removing too much coal and clinker in cleaning fire, shutting down.

Remedy.—Heavy fire, clean clinker from side plates only, use ashes for stopping fires.

SMOKE.

Cause.—Irregular feeding, breaking up fires too often, cleaning fires when green coal is in the fires.

Remedy.—Regular feeding, turning over clinkers on side plates only before drawing out; do not use slice bar too often.

LOSS OF ENERGY.

Cause.—Irregular feeding, drawing out clinkers with green coal clinging to them, pulling out too much fire in cleaning, scale in tubes, leaks causing loss of hot water, excessive forcing.

Remedy.—Constant feeding, turning over clinker before drawing and push off good coal, let all clinker burn out thoroughly before drawing, keep steam pressure up to prevent excessive draft, use a sufficient number of boilers so that forcing is not necessary.

STOKERS.

Faults.—Smoking at hoppers, one feeding faster than others, fire too concentrated, blast on tubes excessive, excessive amount of green coal pulled in cleaning fires, difficulty in cleaning out ashes at back of furnace, burned retorts, cracked retorts, large coal or hard objects breaking stokers.

Remedy.—Burn slack coal only, change stroke of some stokers and work automatics by hand from time to time, build fire-brick arch over retorts or use only with boilers having firebox entirely lined with fire-brick; never use in Morrison suspension furnaces.

fed fastest, and then from time to time work the slow stoker by hand till the fires were about right.

Insisting on these few points and seeing that they were respected resulted in reducing the coal consumption from about 64 or 65 tons per day to about 51 or 52 tons per day, and reduced the smoke at the stack so that most of the time it was difficult to tell by looking at it whether or not the plant was running. Besides the great saving in fuel (this saving was the average before starting to clean the boilers), the saving due to the reduction in tubes burned out amounted easily to $200 per month.

Regarding the stokers, it may be said without hesitation that the under-feed type of mechanical stoker should not be employed in corrugated furnaces, nor with any boilers except those in which the fire is surrounded with a firebrick lining (such as the Cahall vertical), as the blast on the tubes and heating surfaces exposed in the firebox is too intense and is sure to result in constant burning out of these parts. Furthermore, there is great difficulty in keeping the retorts from burning out, and when any coal other than fine slack is employed the smoke coming from the hoppers on the stokers is unbearable and causes loss in economy, because under these conditions it is almost impossible for the firemen to attend to their work properly; in attempting to stop the smoke they will run the automatics by hand and crowd the furnaces so full of coal that it touches the tubes, which was one of the troubles the writer experienced in the present instance. The burning out of the retorts on shutting down was overcome by starting to feed ashes about half an hour before the time to shut down the boiler. This method left the retorts and fireboxes full of ashes when the fire was out, and thus prevented the fire from burning back into the retorts and ruining them.

The foregoing experience is summarized in the accompanying table for the convenience of those who may be interested.

ELECTRICALLY RELEASED BRAKES ON CRANES.

BY ARTHUR B. WEEKS.

The following notes on electrically released brakes and their magnets, for crane service and similar work, are suggested by conditions found in blast furnaces and mills.

All parts of the brake mechanism should be regularly inspected, and repairs attended to as promptly as possible. Usually the one responsible for the motors has the care of brakes and magnets as well. While inspecting and oiling the motors, loose bolts should be looked for, also worn-out cotter pins. Owing to the inaccessibility of some solenoids, this inspection is even more necessary for them. Sometimes wires will be found jarred out of their binding posts, or broken off entirely because of vibrations; sometimes an arc caused by a loose wire destroys a binding-post. Where a wire is found grounded, a piece of Flexduct may be slipped over the wire, which will prove even better than tape.

FIG. 1.—BRAKE SOLENOID.

The application of current to the motor energizes the brake coils, since they are in series with the motor; and the iron core of the brake rigging is drawn up into the magnet coil, which releases the motor brake. Much depends upon the proper adjustment of the brake; if too tight, the motor will heat up very rapidly by taking more current than it should for starting, for there will be a continuous drag on the motor. An ammeter will readily show what the conditions are. If set too tight, the excess current is liable to burn out the motor, as well as the magnet coils.

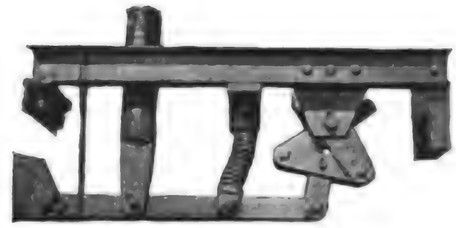


FIG. 2.—BRAKE MECHANISM.

Some mills have neither portable instruments nor ammeters on the switchboard for the several feeders. In the absence of these, inspection must be made, and conclusions drawn from previous experiences. If the circuit is protected by a properly adjusted circuit-breaker or fuse, it is an easy matter to locate the affected circuit. The cause of the excess current must next be determined. This is not always easy; it may be the brake, and it may be due to the careless operating of the motor. The motor itself may be at fault.

The writer has seen heavy pieces of iron hung on brake levers for the purpose of obtaining increased braking effect; at the same time there was an accumulation of oil and grease on the brake band wheel, reducing the braking friction and tending to rot out the leather and cause more trouble. In some mills it is hard to get at things, and a crane can seldom be spared for long; this tends often toward neglect.

When magnet coils are removed for any purpose, they should be tagged with full particulars, and either repaired or reported to the proper parties at once. If not in close touch with the manufacturers, an extra coil should always be kept on hand. Several different sized wire coils should be avoided, one size being kept as a standard. This of course refers to any one motor, each size of wire varying with the size of motor.

Certain conditions in this service require careful study. Conclusions should never be jumped at, but should be carefully thought out step by step. Sometimes these magnets or brake solenoids become excessively hot, burning off the outer insulation, and if wound with cotton covered wire, the entire coil is rendered useless. This is not so if asbestos-covered magnet wire has been used. This wire is coming into more general use since its manufacture has been cheapened. Pure asbestos-covered wire will easily withstand the heat should the wire

become red hot. One make of wire the writer has tested in this way with very good results. It should be specified for all purposes where there is excessive heat, or frequent burnouts. It is valuable for field coils, lifting magnets, arc lamp coils, circuit-breakers, etc., and many armature coils are now being wound with it.

Since the coils for blast furnaces and similar mills are more or less exposed to the weather, it is a very good plan to treat them with a good insulating paint, to exclude moisture; for asbestos is likely to absorb a great deal of water if exposed in moist surroundings. The wire can be obtained from the manufacturers already treated with insulating paint, and is known as "fire-and-wateproof asbestos magnet wire." If this is used, the exterior should be painted with a paraffine black paint.

CORROSION IN BOILERS.

The July *Bulletin* of the Fidelity & Casualty Company contains an interesting note on boiler corrosion. The pipe illustrated by Fig. 1 was removed by one of the company's inspectors from the inside of a boiler. The pipe was connected to the feed pipe supplying the boiler in question. It is, of course, known that corrosion takes place to a greater or less extent in all steam boilers. The feed-water in this particular case was almost free from solids tending to form incrustation or scale, and as far as could be ascertained no great amount of acids was present. The pipe was attacked very much more rapidly than the other internal surfaces. The capricious action of water emphasizes the need of precaution and skill in searching for and determining resultant conditions. In one boiler the action may be along the water line, perhaps heavier at one end than the other. In another the damage may be along

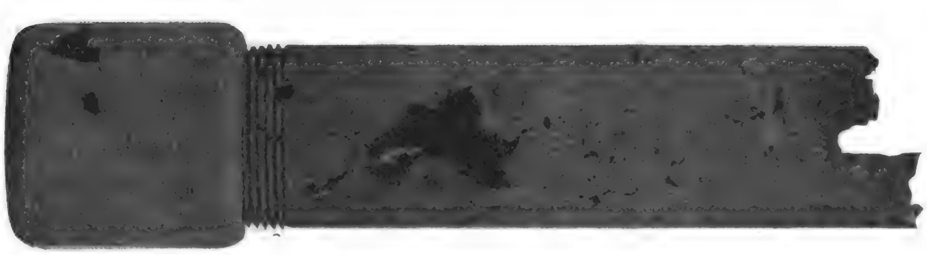


FIG. 1.—EFFECT OF WATER ON BOILER FEED PIPE.

the bottom surfaces or on the tubes, mud-drum or feed pipes. The only way to determine whether a boiler is affected is by careful examination by a competent person. The moderate use of soda appears to be a favorite remedy for corrosion. Kerosene oil is also used with good results. In many instances painting the surface with graphite has proven beneficial. Where the metal is rapidly acted on an analysis of the feed-water should be made to determine what chemicals should be introduced in the feed-water to counteract the conditions causing corrosion.

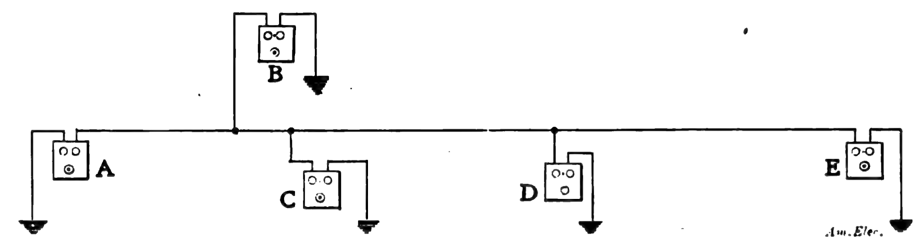
Letters on Practical Subjects

Communications intended for publication in this department must be received at this office not later than the 15th of the month prior to the date of publication.

Heating Greenhouses Electrically.

We should like to obtain information regarding the electrical heating of greenhouses. If any readers of the AMERICAN ELECTRICIAN who have had any experience in this class of work will communicate with us, or if anyone can refer us to parties who have had such experience, we will appreciate the favor. We believe there is an inviting field for electric heating in this branch of business.

FLORISTS' PUBLISHING COMPANY.
Chicago, Ill.



MR. BRAZELL'S PROBLEM IN TELEPHONE CIRCUITS.

Mr. Brazell's Telephone Problem.

Referring to the problem in telephone circuits presented by Mr. J. R. Brazell last month I should think there was too much resistance in the ground connection at Station *C*. At any rate, the output of generator current from that station is not enough to ring all the bells at once. The fault might be in the generator, however; but it is much more likely to be in the ground connection, or in the branch connection from the main line. The bell at Station *A* probably requires more current than any of the others, and being of low resistance probably gets more, but the fact that Station *B* can ring all the bells shows that the branch to Station *A* does not take so very much more current than one of the others. Therefore, as the output from *C* is below normal, the current taken by Station *A*, although perhaps greater than that taken by any of the others, might not be sufficient to ring the series bell at Station *A*.

Reading, Mich. FRANK W. BONE.

The cause of Mr. Brazell's telephone trouble probably is either that the generator at Station *C* is weak, or the resistance of the ground connection there is abnormally high—most likely the latter. It takes so much more current to ring an 80-ohm bell than one of 1,600 ohms that if the resistance in the branch circuit at *C* is very high the generator there cannot supply sufficient current to ring the 80-ohm bell at *A*, although it might furnish enough to ring the others. When Station *C* is called up, its ground circuit needs to pass only 1-20 of the current that it must pass in calling the other stations from there; this accounts for the fact that the other stations can call *C*. A series generator would ring at least ten 1,600-ohm bells on a 20-mile circuit, so that one would expect Station *A* to be able to call up the other stations.

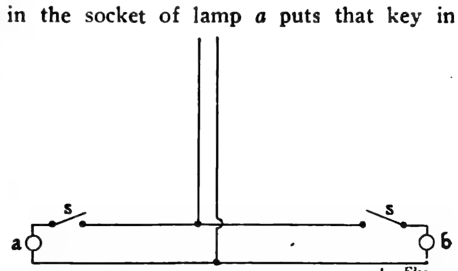
Mesa, Ariz. FRANK W. CERNY.

Mr. Brazell's problem in telephone circuits may be solved by assuming that the generator at Station *C* is too weak to furnish the heavy current necessary to ring the 80-ohm bell at Station A, the 1,600-ohm bells at the other stations requiring much less current. The generators at the other stations, being stronger, are able to ring the 80-ohm bell.

Philadelphia, Pa. W. A. LOVELAND.

Mr. Fuller's Electrolier Trouble.

If the lamp sockets on Mr. Fuller's electrolier are of the Edison type, and if the screw shell is in contact with the main shell of the socket and the turning of the key in the socket of lamp *a* puts that key in



MR. FULLER'S FAULTY ELECTROLIER CIRCUIT.

contact with the socket shell, then a set of conditions exists which will produce the results described in Mr. Fuller's letter last month. I cannot see, however, how such conditions could exist unless the linings were left out of the sockets.

Reading, Mich. FRANK W. BONE.

Referring to the electrolier trouble described last month by Mr. Fuller, I would suggest that the current-carrying parts of the sockets are grounded on the socket shells. I have had the same trouble on old electroliers on which inclined key-sockets were used, and always found the grounds in the sockets.

South Fork, Pa. Alex. M. Cover.

[That the live parts of the sockets were grounded is perfectly obvious; the question is, how and where?—Editor.]

Regarding Mr. Fuller's electrolier trouble I would suggest that the socket switch parts are grounded on the socket structure, so that the two sockets are cross-connected through the electrolier, as indicated by the accompanying sketch, in which the dotted line represents the accidental connection established by the two grounds and the piping. The grounding at the socket *a* occurs only when the key is turned to light the lamp. The sockets are probably unlined and the electrolier may be wired up with lamp cord.

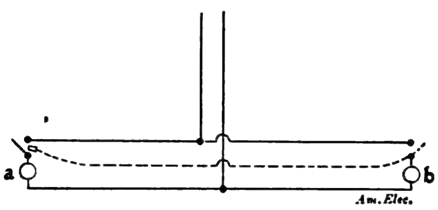
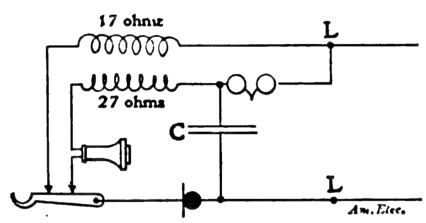


FIG. 1.—MR. HARTMAN'S SOLUTION.

Scranton, Pa. H. F. Hartman.

The Hayes Telephone System.

In Mr. Enoch's letter last month, correcting a statement concerning the Hayes common battery system, there occurs an error which is made by most people who have had experience with the old telephone exchange system using local batteries and have since engaged in work with common battery systems. He states that in the Hayes system the *secondary* of the subscriber's induction coil is shunted by a condenser. The general impression is that the low resistance winding is always the primary and the high resistance section the secondary, but this is not true. In the Hayes system, the winding which, by the action of the transmitter induces impulses in the line, is the high-resistance winding, and its action is obviously primary. Referring to the accompanying diagram of connections, the current from the common battery enters the subscriber's set at the terminals *L L*, and charges the condenser *C;* when the resistance of the transmitter is lowered by the compression of the carbon, during use, the condenser discharges through the local circuit comprising the transmitter, receiver and 27-ohm winding, this impulse inducing a corresponding one in the 17-ohm winding, which delivers it to the line; when the resistance of the transmitter increases, the condenser becomes charged again, and so on. Incoming talking currents, of course, pass through the 17-ohm winding and induce impulses in the 27-ohm winding which act on the receiver.



HAYES TELEPHONE CIRCUIT.

Philadelphia, Pa. W. A. Loveland.

[Mr. Loveland's explanation, while ingenious, is not quite accurate. What actually happens is that a steady current flows through the 17-ohm coil and the transmitter in series when the hook switch is up and no one is talking; talking in the home transmitter produces variations in the line resistance and current which actuate the distant apparatus quite independently of the home induction coil—if the 27-ohm winding were cut out of circuit the operation would not be disturbed. Incoming currents act as Mr. Loveland mentions, so that when the induction coil *is* in active operation the low-resistance winding is the primary.—Editor.]

Mr. Merrill's Bell Connections.

The accompanyng diagram (Fig. 1) is offered as a solution of Mr. Merrill's problem in bell circuits, published in this department last month. Two-way or double-contact push-buttons are used at the middle station and ordinary pushes at the others. One terminal of each bell is permanently connected to the common return wire from the battery. Depressing push-button *1* connects the other terminals of all three bells to the battery through the annunciator drop *a;* depressing the button *4* does the same through the drop *c*. Depressing button *2* connects the terminals of bells *A* and *B* directly to the battery, and depressing the button *3* does the same with the + terminals of the bells *B* and *C*. The annunciator drops must, of course, have very low resistance windings.

Washington, D. C. N. P. Bethel.

[The same solution was supplied by Edw. R. Fisk, West Springfield, Mass.—Editor.]

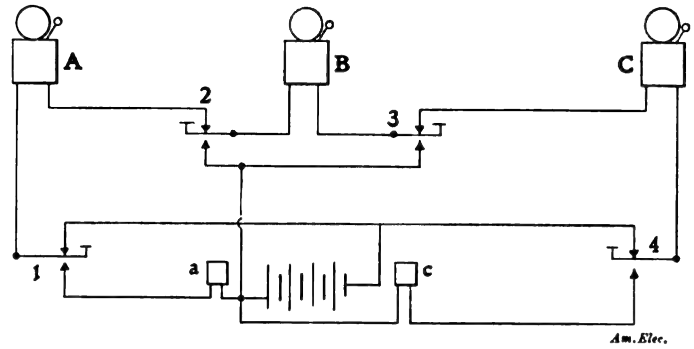


FIG. 2.—MR. BONE'S SOLUTION.

Mr. Merrill's problem can be solved by the arrangement shown in the enclosed diagram (Fig. 2). The push-buttons are all of the two-way type. Depressing No. 1 puts all the bells in series with each other and the drop *a* and the battery; depressing button *4* does the same, except that the drop *b* is included instead of *a*. Button *2* connects bells *B* and *C* in series with each other and the battery, and button *3* makes the same connections for bells *A* and *B*.

Reading, Mich. Frank W. Bone.

[The same solution was furnished by Alex. M. Cover, South Fork, Pa.; Edw. R. Fisk, West Springfield, Mass.; H. F. Hartman, Scranton, Pa., and H. C. Storm, New York.—Editor.]

The enclosed diagram (Fig. 3) is submitted as a solution of Mr. Merrill's problem in bell circuits. All of the push buttons are of the ordinary single-contact variety. Depressing No. 1 completes the series circuit through the three bells and battery

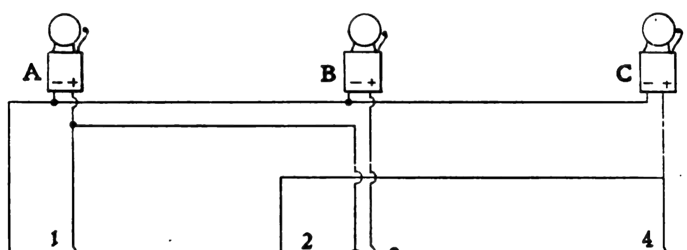


FIG. 1.—MR. BETHEL'S SOLUTION.

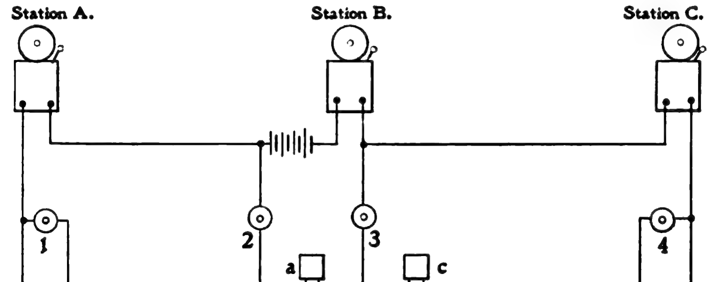


FIG. 3.—MR. HANSON'S SOLUTION.

by way of the drop *a* and the wire *z*; depressing the button *4* does the same through the drop *c* and wire *y*. The button *2* puts the battery and bells *B* and *C* in series through the wire *z* direct, and the button *3* connects the battery and bells *A* and *B* in series through the wire *y*. This arrangement could be used for vibratory signals by making the bell *B* a vibrating bell and the other two single-stroke bells.

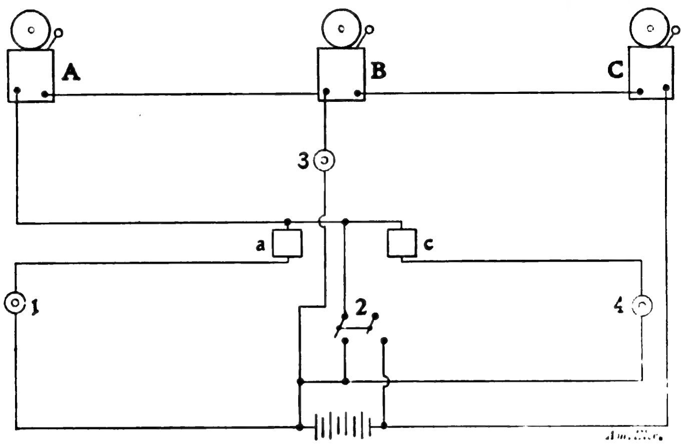


FIG. 4.—MR. WILCOX'S SOLUTION.

State Farm, Mass. W. G. HANSON.

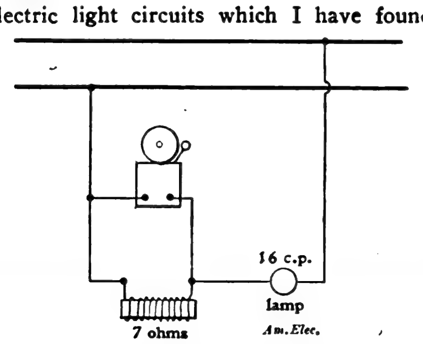
[This solution was also supplied by Edson J. Nash, Ontario Centre, N. Y. It is identical with that of the author, Mr. Merrill.—EDITOR.]

The accompanying diagram (Fig. 4*) shows one way of meeting the requirements of Mr. Merrill's problem. The button *2* is a double-contact (but not a two-way) push; the others are ordinary single-spring buttons. Pressing button *1* connects all the bells and the drop *a* in series with the battery. Pressing button *2* connects bells *A* and *B* in series with the battery; button *3* does the same with bells *B* and *C*, and the button *4* puts all the bells and the drop *c* in series with the battery.

Scottdale, Pa. E. A. WILCOX.

Bell Operation from Lighting Circuits.

The accompanying diagram illustrates a method of operating electric bells from electric light circuits which I have found very satisfactory. The resistance across the terminals of the bell (when the button is closed) consists of about 20 to 25 feet of No. 21 German silver wire; the lamp is an ordinary 16-c.p. incandescent.



BELL OPERATED ON LIGHTING CIRCUIT.

Zanesville, O. ALEX. WEINBERG.

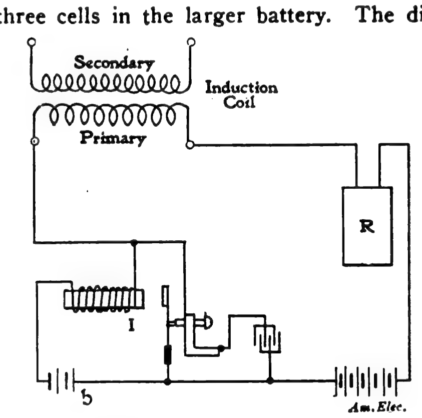
* A line is omitted in the engraving connecting the right-hand terminal of the bell *B* to the right-hand terminal of switch *2*.

Induction Coil Operation.

The method of controlling the excitation of an induction coil that is illustrated by the enclosed diagram is offered as an original and possibly useful "kink" for the benefit of other readers. The interrupter, *i*, is entirely separate from the induction coil and is operated by the small battery *b*. A water resistance, *R*, is in series with the main battery, interrupter contacts and induction coil primary, and serves to regulate the strength of the primary current; a much smoother gradation is obtainable with this than with any multiple-contact rheostat. The current from the interrupter battery and that from the exciting battery flow in parallel through the interrupter contacts when they are closed, the two batteries being opposed. The condenser is in shunt to the contacts, as usual.

Los Angeles, Cal. ROY C. JACKSON.

[The arrangement shown has the disadvantage that when the interrupter contacts open, current from the large battery will continue to flow through the interrupter magnet and the induction coil primary, though this current will, of course, be reduced by having to pass backward through the small battery; if the two batteries have two and five cells, respectively, this reduced current will be that due to the surplus of three cells in the larger battery. The difference between the exciting current when the contacts are closed and that when they are open will, therefore, be considerably less than if a single battery were used and the interrupter magnet connected in series with the primary of the induction coil.—EDITOR.]



INDUCTION COIL OPERATION.

A Problem in Mechanics.

The accompanying sketch represents a plank 10 feet long, weighing 10 pounds (a pound per foot of length) and supported on two knife edges, as shown. At one end, 2 feet of the plank projects beyond the near support, and at the other, the overhang is 3 feet long. The problem is to determine the amount of weight or downward pressure on each of the supports.

Colton, Cal. L. P. BRODE.

Mr. Wolf's Telephone Trouble.

I think the cause of Mr. Wolf's telephone trouble is as follows: While raising the hook switch at *B* does cut out *A* in a way, he still has his receiver between two condensers on one wire. The charging current of these condensers is enough to give indistinct conversation. His trouble at station *B* is probably due to low insulation between the three wires. A telephone receiver is so sensitive that in experimenting with it one finds many things that are quite puzzling. If one terminal of a receiver be connected to the secondary of a small medical coil and the other receiver terminal be held in one's hand, the buzz of the vibrator can be heard, even when everything in circuit is highly insulated. The observer's body takes enough charging current to operate the receiver.

Mesa, Ariz. FRANK W. CERNY.

The July Problems.

In answer to the several questions published in the July number, I wish to suggest to Mr. Miller, in respect to his faulty electrolier, to examine carefully the socket at the lamp *b*; in so doing I believe he will find his trouble.

Mr. Brazell's telephone trouble looks like a weak generator at Station *C*, providing the distances between the different stations are approximately the same. If he has not already made the test I would suggest he change generators with Stations *B*, *D* or *C* to make sure.

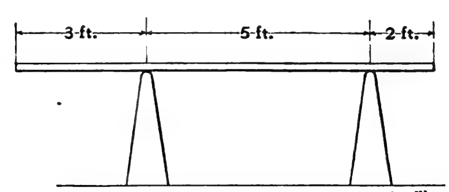
As to Mr. Wolf's telephone trouble, I recommend good insulation for those lines running outside. This, I believe, would clear his trouble, as a very slight leak between wires No. 2 and No. 3 would produce the effects mentioned.

Bad connections are, no doubt, the cause of Mr. Parrish's trouble. The Gamewell fire alarm people, as a rule, turn out splendid apparatus. I believe by throwing battery on the lines and testing with an ordinary telephone receiver a great deal of the trouble would be located.

Washington, D. C. N. P. BETHEL.

Mr. Loveland's Criticism.

In answer to Mr. Loveland's remarks as to my telephone signaling diagram, shown in the June number, I beg to say that in some cases ring-overs will occur and I believe in all cases should the party being rung remove his receiver from the hook others parties would be signaled unless a special relay is inserted in the ringing circuit to operate under certain line resistance. However, I think Mr. Bone's solution



PROBLEM IN MECHANICS.

would be satisfactory. As to the push-button and bell arrangement, I leave that to other readers; I've never tried such an arrangement. I realize it would hardly stand the underwriters' test; I merely suggested it as a possibility. I enjoy these criticisms. They compel one to gain knowledge that otherwise would never be thought of, and I also find such knowledge very beneficial.

Washington, D. C. N. P. Bethel.

Alternating-Current Power Measurement.

It is desired to measure the power output in a three-phase, 2,300-volt, delta connected system. Three recording wattmeters are to be used in conjunction with current and potential transformers. The wattmeters have a rating of 5 amperes, 220-volt; current transformers have a ratio of 160:1 with 5 ampere secondary and potential transformers have a ratio of 10 or 20:1. Give and explain diagram of connections and develop the constant for the meters. In case the meter constant proves to be an awkward number to handle, what can be done to make same an even number without altering the ratio of the current or potential transformers? I will appreciate any suggestions that other readers may offer.

Oakland, Cal. S. J. Lisberger.

Mr. Parrish's Difficulty.

Regarding the inquiry of Mr. Parrish in the July issue as to the trouble on his fire alarm system at Great Barrington, Mass., I beg to say that he answered his own inquiry at the outset of his letter when he said: "The wires were not soldered at any of the connections and the work was performed in a very slipshod fashion." Poor joints in the line will account for everything that has happened. A 20-ohm magnet, such as is used in most fire alarm indicating devices, will retain its armature with less than half the normal current of 10 milli-amperes; but when once released it cannot "pick up" with such a small flow of current. A bad joint in the line will do no harm if undisturbed, and very often it will permit the normal current to flow; but when once the circuit is opened, upon again closing it the resistance of this joint will usually be found to have increased enormously. The action is somewhat similar to that of the anti-coherers used in wireless telegraphy.

It can easily be seen that with the starting of the gear train in a fire alarm box and the opening and closing of the circuit through the fingers and break wheel, or similar devices in the box, the bad joint will permit the first blow and perhaps others; but its resistance is constantly varying and some signals will be transmitted correctly while others will be lost, thus causing entirely different spacing and consequently wrong box numbers.

Your correspondent will continue to have this trouble as long as he has a single bad joint in his line. The only remedy is to solder or sleeve them all. Fire alarm apparatus is usually well made, and with ordinary care can be relied upon, but slipshod installation of it is, to my mind, little short of criminal. Not only property but lives often depend upon its proper action, and to spend money upon anything but the best for everything connected with the system is a public outrage.

I would venture to suggest that if the Great Barrington fire alarm system is not provided with a first-class voltmeter and millammeter, but relies upon a galvanometer to ascertain the condition of its battery and line, as too often is the case, it should at once discard the latter instrument and purchase the two former. Periodical readings of both voltage and current will tell the story of the poor joints in an unmistakable manner. I would also suggest that if the superintendent of the system in question will join the International Association of Municipal Electricians he will be enabled to keep in touch with men who have devoted much time and thought to improvements in this branch of work and whose experience will be valuable to him.

Rutherford, N. J. Walter M. Petty.

Difficulty in Paralleling Two Three-Phase Generators and the Cause.

The following incident reveals some reasons why it is hard to get two generators together on the same bus line; the fault of this case being purely mechanical.

We had two 800-kw. three-phase railway units installed, and the writer was urged to get them into operation as soon as possible. These generators were each coupled to a 1,200-h.p. cross-compound engine of a well-known make. On starting these units it was found that the regulating weights on the governors would have to be taken off in order to get the speed called for, 94 r.p.m. This permitted the units to be thrown together and operated in parallel; but after a time, however, it became difficult to hold them together, the high-tension switches opening because the machines were not in synchronism.

The offending unit was detected in the following manner: There would be a large variation in the receiver pressure and when throwing the generators together the receiver pressures had to be as near the same as possible. The offending unit became more sensitive and began to lag on heavy loads, producing cross feed on the generators. All joints and pipes were examined for leaks, but were found tight. The low-pressure piston heads were also examined and found in good shape. An indicator was ordered, but before it arrived the seat of the trouble was revealed; the high-pressure piston rod carried out with it a yellow substance combined with cylinder oil. The unit was shut down as soon as possible and the cylinder head was taken off. The follower plate was next removed and we discovered a broken ring and broken studs. The system of packing used was entirely new. There were two large phosphor-bronze rings with a steel spring ring within these to set them out and jack screws to hold them in position. Three bearing shoes were provided on the bottom side to carry the weight of the piston head. The shoes bore against steel ring and were adjusted by jack screws, the other ends of which were in a plate set in recesses at the boss on the spider. The follower plate did not bind these rings tight, but allowed for adjustment. The jack screws were of phosphor-bronze. In this case the bottom jack screw had broken, allowing the spider or piston head to drop, breaking the large packing rings in two places. This was the cause of the behavior of the engine and receiver trouble. A bull ring with cast-iron spring rings was ordered to be put in place of the broken rings and the units placed in operation as soon as possible, these units being in constant demand.

A short while after, the other engine began to show the same symptoms as the first, and in the meantime another bull ring had been ordered and we were awaiting its delivery. The day before it arrived a thump was heard in the high-pressure cylinder of this unit, which sounded as if everything had been smashed to pieces. The unit was disconnected, the cylinder head taken off, and an impression was seen on the cylinder head as if a substance had been compressed. When the piston head was brought to the back end of the cylinder there was a hole in the follower plate and a piece of bronze was also found mashed flat. Further examination of the exhaust valve and seat showed that this bronze bolt had passed to the exhaust port and the valve had cut a part of it off, twisting the stem. On removing the follower plate the same conditions were seen to exist as in the first engine with the exception of the hole in the follower plate. When one of the jack screws broke it fell down and as the piston head travelled back and forth this bolt hammered a groove in the iron about five inches long, half way through the plate; then, for some cause or other, it shifted its position to a point where the iron was probably softer and cut a hole diagonally through the iron about an inch and a half in diameter and got out with the above results. The hole appeared to be as if rolled; it was smooth—a case of soft metal cutting through a harder one. The bottom studs were broken in two pieces and ground into balls. The large rings were broken in three places. The new bull ring and follower were put in and this was the end of that method of packing.

As constructed, the slight clearance between the shoe carrying the weight of piston head and follower caused it to vibrate back and forth with the result that this continued action broke the jack screws. After the repairs to the engine were made the matter of regulating weights was taken up and pulleys of smaller diameter were put on the governor shaft, which caused the engine to run at 96 r.p.m. without the weights. After the weights were put in position and adjusted the engines were brought down to a speed of 94 r.p.m. Since the change the generators can be thrown in parallel without any trouble.

Osborn, O. H. C. Reagan.

Questions and Answers

Inquiries not accompanied by the name and address of the inquirer, will not receive attention.

Please give data for an induction coil to give a 3-in. spark when supplied with alternating current at 110 volts and 133 cycles. H. E. B.

We regret that we have no data for such a coil.

How can a three-wire circuit supplied from a single 250-volt dynamo be balanced when some lamps are turned off on one side of the middle wire? J. R. W.

Either by installing a motor-balancer or by using a three-wire generator, which is equipped with autotransformers for balancing the circuit.

What is meant by a 7 x 6 x 8 single acting pump? (2) What is the relation between the power factor and the efficiency of an alternating-current motor. G. R. M.

A pump having a steam cylinder 7 in. in diameter, a water cylinder 6 in. in diameter and a stroke of 8 in. (2) There is no direct relation; a low power factor, however, reduces the efficiency by increasing the copper loss for a given output.

Is a special rheostat necessary for an alternating-current motor, or can the same rheostat be used as with a direct-current motor? H. C. McI.

The rheostats are entirely different in construction and application; they are somewhat similar in general principle only, being employed to keep down the initial rush of current. A direct-current rheostat, therefore, would be useless for starting an alternating-current motor.

How many square inches of tinfoil will be required for a condenser to be used with an induction coil having a core 1¼ in. in diameter and 10½ in. long, a primary winding of two layers of No. 15 wire and a secondary winding of forty layers of No. 30 wire? M. M. H.

Use sixty sheets 6 in. by 10 in. Your coil, however, is not well proportioned; eight pounds of No. 36 silk-covered wire will give much better results; the core should be 2 in. longer and the primary wire should be No. 12 or No. 13.

What is the inductive effect upon two parallel wires carrying alternating current? (2) What is the effect when the wires are in separate conduit pipes? (3) How can induction troubles be overcome? H. B. R.

It is a counter e.m.f. produced by the magnetic field set up around each wire by the alternating current in the wire. The farther apart the wires are, the greater the inductive effect. (2) If the conduit is iron, the effect is greatly enhanced and may easily render operation impracticable. (3) By putting both wires in a single conduit pipe.

How can I test a T.-H. wattmeter for accuracy, having only a bank of lamps, a voltmeter and an ammeter? (2) Can two or more transformers of different capacities be operated in parallel at both the primary and secondary terminals? E. A. T.

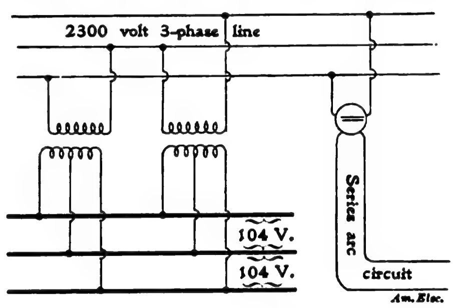
Connect the wattmeter, the voltmeter and the ammeter in circuit with the lamps in the usual manner and supply the lamps with current at the proper voltage for one hour. Watch the voltmeter and ammeter to make sure that no variation in the voltage and current occurs. Multiply the voltmeter reading by the ammeter reading and the result will be watt-hours; take the reading of the wattmeter and compare it. (2) Yes; provided the two are of the same type.

Does an old incandescent lamp take more current than a new one? (2) Why does the current taken by a lamp vary with service? (3) Why do electric lighting companies make a practice of changing their customers' lamps after they have burned a certain number of hours? W. W.

No; it takes less current, but takes more current per unit of light emitted because the illuminating power decreases more rapidly than the current "consumption." (2) Because the resistance of the filament increases during the period of service, due to the gradual wasting away of the carbon. (3) Because the candle-power has become so reduced at that point that the illumination is unsatisfactory, and it pays better to smash the lamps than to have the service poor.

Can incandescent and arc lights be operated from a single three-phase primary circuit, the incandescents being supplied on the three-wire plan from two phases and the arcs from one of the phases of the primary line, as shown by the accompanying diagram? W. T. K.

Not in the way your diagram shows. The plan would be all right, however, if the three-wire secondary mains were cut between the leads from the two trans-



formers so that each transformer supplied its lamps separately. With the connections you show, each constant-potential transformer will short-circuit the other during two-thirds of each cycle, the two phases to which they are connected being one-third of a cycle out of step with each other.

Why can a higher current density per unit of cross-section be employed in an armature winding than in a field winding? (2) What is a safe density for armatures running at ordinary speeds (belted) and in open field magnet frames? (3) Which is preferable for gas engine ignition, a self-exciting dynamo or a magneto, and why? W. T. K.

Because the ventilation is so much better in the armature. There are only a few layers and these move at a high speed, whereas in a field winding there are many layers and the winding is stationary. The radiating surface of an armature per ohm-foot of conductor is much higher than that of a magnet coil. (2) From 2000 to 3000 amperes per square inch of cross-section, according to speed and radial depth of winding. (3) A magneto, because it has a constant field strength regardless of its speed.

What voltage do the Underwriters favor in the lighting of large buildings? (2) Is it considered safe to supply a building with current at 220 volts, or would it be necessary to put in a balancer and supply the current on the three-wire, 110-volt plan? J. T. J.

Any voltage up to 300. (2) The two-wire, 220-volt system is as safe as a three-wire system with 110 volts between the neutral and each outer wire. The latter is a 220-volt system merely divided into two branches, and the division does not make it any safer. As a rule it is preferable to distribute on the three-wire plan, however, because of the higher efficiency of the 110-volt lamp as compared with the 220-volt lamp.

What is the cost of building the electric runabout described in the January, 1903, number? (2) Where can the castings be procured? (3) What is the material and the thickness of the armature core discs? (4) Are the armature coils closed up after winding and both sides put in the same slot? (5) The drawing shows four terminals to the field coil; should there be four or two? H. E. J.

We do not know. (2) We know of no source whence castings can be obtained; it was the intention that the builder should have the castings made. (3) Low carbon annealed sheet metal, not thicker than 25 mils and not thinner than 15 mils. (4) No; each coil should embrace six armature teeth. (5) Two; a drawing of a four terminal coil of the same dimensions was used by mistake.

Please give data for winding the motor described in the July number to operate at 230 volts. (2) What will be the best method of obtaining five speeds from this motor, say 500, 875, 1250, 1625 and 2000 r.p.m.? (3) What will be the power of the motor at each of the speeds mentioned? E. B. B.

It is impracticable to wind the motor for 230 volts without re-designing the armature and commutator, and we are unable to spare the time necessary to do this. (2) The most economical method would be to change the battery connections to give voltages in the proportions required for the different speeds. In practice, however, it would be better to combine fewer changes in battery connections with rheostat control. (3) The power would be roughly proportional to the speed.

How can the torque of a direct-current motor be increased? (2) In rewinding a 220-volt armature for 110 volts what changes are necessary besides increasing the size of the wire? (3) At what point of the piston stroke of a gas engine should the ignition occur? (4) What is the advantage in making the point of ignition adjustable? J. L. V.

If the machine is not too near its sparking limit an armature of slightly larger diameter can be used, thereby reducing the air-gap and increasing the magnetic flux. It will be necessary, in order to obtain the same speed as before, to reduce the number of armature coils, which means, of course, the entire re-designing of the armature and commutator. More explicit instructions cannot be given without complete knowledge of the design. (2) Reduce the number of turns per coil to one-half the present number, using the same number of coils. (3) This depends upon the speed of the engine. In most cases ignition occurs just as the crank reaches the inner center. (4) In order that the most favorable point of ignition may be obtained with different speeds or different mixtures. The higher the speed, the earlier should be the ignition in order to allow time for the mixture to become fully ignited before the crank passes the center.

MAGNETIC COUPLING AND SPEED ACCELERATOR.

The Cutler-Hammer Manufacturing Company, of Milwaukee, Wis., has been carrying on experiments for several years in the development of magnetic couplings and accelerators. The Cutler-Hammer Clutch Company has now been organized for the manufacture and sale of this apparatus, and it announces that it has designs and equipment for the manufacture of a complete line of these couplings and accelerators. The magnetic couplings consist of two cast-steel rings mounted concentric with the shafts to be coupled. One of these rings has an annular groove, in which the magnetizing coil is securely fastened, the other ring acting as the armature or keeper. A cross-section of the two members shows the well-known form of a horseshoe magnet and its keeper. This device is applicable wherever the shafts to be coupled are at rest

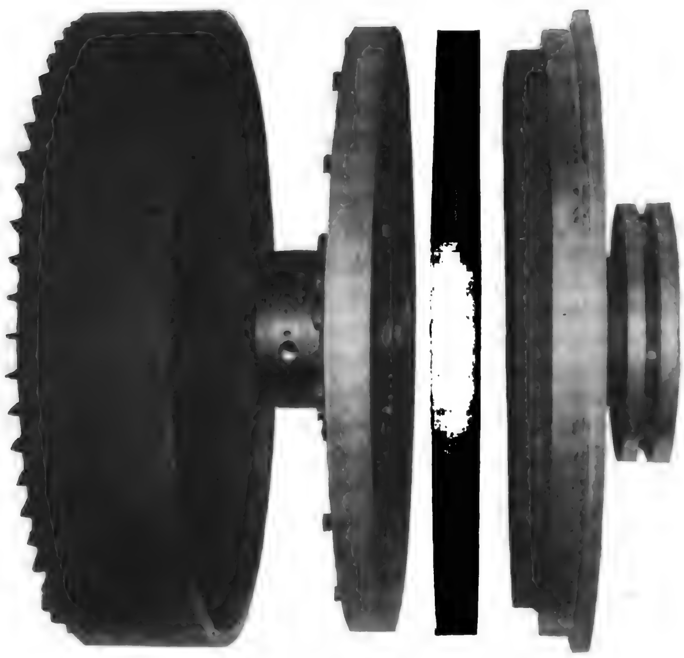


FIG. 1.—PARTS BEFORE BEING ASSEMBLED.

or both running at the same speed when the coupling takes place. They can also be used to cut out a machine or section of shaft when in rotation, giving, it is claimed, a prompt and absolute release regardless of load. The magnetic speed accelerators are used for the same purpose as the ordinary friction clutch, except that they have a much wider range of application. The torque in these clutches is the sum of two components, one due to friction and one due to eddy currents induced to the armature plates, by the magnetism of the field, which is specially constructed to secure this result. At the moment of starting the induction component or torque is a maximum, dropping off as the driven member attains speed. In starting up a load with the ordinary friction clutch it is a noticeable fact that the pressure on the operating lever is eased the moment the load begins to move, in order to obtain a smooth start. In the accelerator this is accomplished automatically by the dropping off of one component of the torque, the result being a remarkably smooth acceleration, which can be controlled, if desired, by means of a rheostat. In practice these accelerators find their readiest appli-

FIG. 2.—FIELD IN THE ROUGH.

cation to that class of service where it is desired to control moderate or large-sized units by some form of automatic device, such as a float switch, relay or electrical

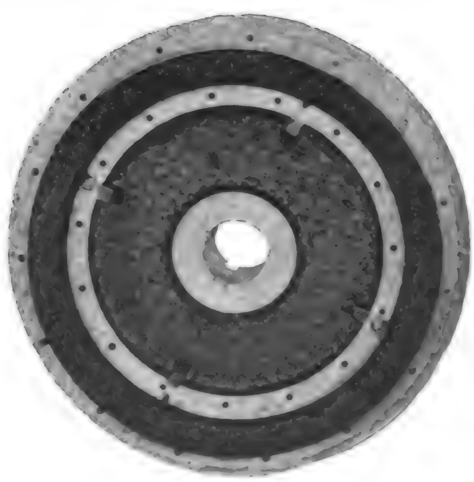


FIG. 5.—BACK PLATE WITH COIL.

contact of any kind. For most work they can be thrown directly across the line without danger from shock or jar, as it is practically impossible to produce a sudden jerk with them. The simplicity of their construction renders them easily balanced for speeds much higher than that for which the

FIG. 3.—FIELD BABBITTED.

ordinary clutch is available. The small currents used in the magnetizing coil results in a simple and cheap controlling apparatus, two amperes being sufficient to control a 100-h.p. unit at the ordinary speed. They are designed and built for heavy service, and ample wearing surface is provided, so that no adjustment for wear is necessary.

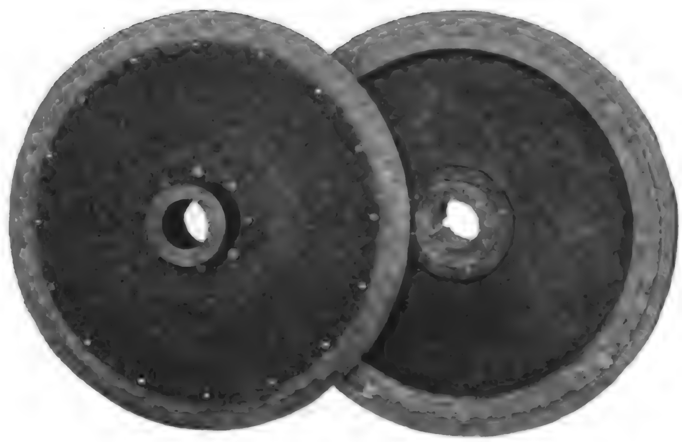


FIG. 4.—PARTS OF MAGNETIC COUPLING.

In connection with gear trains this device is also used to operate a machine at differ-

FIG. 6.—BACK OF FIELD.

ent speeds, and this arrangement has been proven very satisfactory in practice. The principles of design and construction, as well as many applications of these accelerators, are protected by patents.

New Apparatus and Appliances

HASSEL LIMIT SWITCH.

Fig. 1 herewith shows the general features of the Hassel limit switch for electric cranes brought out by the Rex Filter Manufacturing Company, of Pittsburg, Pa. The purpose of the switch is to prevent such conditions on electric cranes known as running block to block. Modern electric cranes equipped with two and sometimes three hoisting motors are operated by one crane

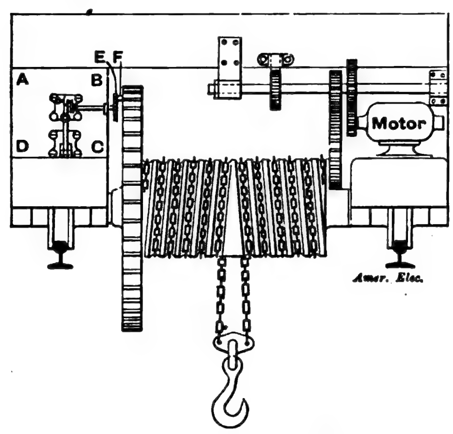


FIG. 1.—HASSEL LIMIT SWITCH.

man from his cage. It frequently happens that two of these motors are set in operation at the same time, one possibly with load and the other more usually without load. Through carelessness one is allowed to operate, attention possibly being diverted by the other, until it runs too high and blocks and hook are drawn together. Before it is noticed the accident occurs which results in a bent shaft, gears broken and other parts injured. The part the Hassel limit switch plays when installed, is to break the current at the critical moment. Fig. 2 illustrates the manner of attaching the switch, *ABCD*, to the crane. Each time the hoisting drum on the crane makes

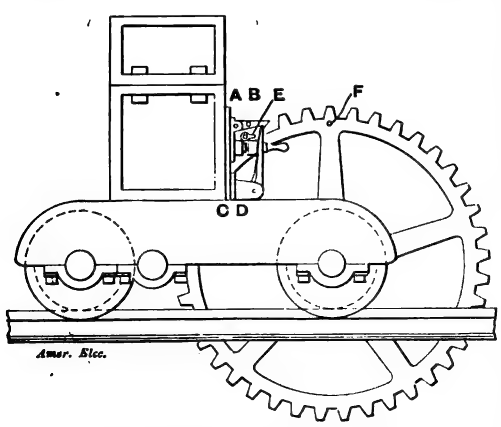


FIG. 2.—HASSEL LIMIT SWITCH.

a revolution, a pin, *F*, engages the star wheel, *E*, and moves it one tooth forward. The star wheel is attached to a shaft, at the other end of which is a tripper. When the drum has made a prearranged number of revolutions and consequently moved forward the star wheel a like number of cogs, the tripper on the shaft opens a lock and the circuit is broken. If, however, the danger point is not reached and the drum is reversed, the star wheel and tripper shaft likewise reverse and the contact is not broken. To accommodate the number of drum revolutions necessary to bring the hook from the floor to the block a star wheel with a corresponding number of teeth is used. Gears to double the revolution of the shaft are introduced when over fifteen turns of the drum are necessary to wind up the chain.

NEW ENGLAND DYNAMOTOR.

The dynamotor illustrated herewith represents a peculiarly handy machine for use in charging motor batteries, or for such other purposes as may require the transformation of direct current from one voltage to another. As will be noticed, it is of the cradle type, the armature being mounted in a yoke or cradle, entirely independent of the field frame, and removable therefrom without disturbing the bearings. Owing to this peculiarity of construction the machine can, of course, be assembled for support either on the floor, or from a wall or ceiling, and has this ad-

FIG. 3.—NEW ENGLAND DYNAMOTOR.

vantage over the bracket type, in that it is impossible for the bearings to get out of alignment when changing from one form of support to the other. The machine illustrated was designed for the operation of a large X-ray outfit, and is intended to deliver 30 amperes at 110 volts on the low pressure or secondary side, using 220-volt current at the primary. The New England Motor Company, of Lowell, Mass. ,the builder of the machine, makes a complete line of these dynamotors.

NEW POLYPHASE INDUCTION MOTOR.

The Westinghouse Electric & Manufacturing Company has placed on the market a new type of polyphase induction motor known as type CCL. These motors are manufactured in sizes ranging from ½ to 75 horse-power, and are wound for operation on two or three-phase circuits at voltages of 200 and 400 for all sizes except the ½ horse-power size. The sizes from ½ to 5 horse-power, inclusive, are also wound for 100 volts. The frame of the motor consists of a solid, cylindrical, cast-iron yoke to the ends of which are bolted brackets which carry the bearings. These brackets are open so as to provide good ventilation, and may be fastened to the frame in any of four different positions, making the motor suitable for floor, wall or ceiling mounting. Motors up to and including 5 horse-power have solid brackets and bearings, with slotted holes in the feet for adjusting the tension of the belt. Larger machines have the brackets and the bearings split horizontally, greatly facilitating the removal of the bearings, should this become

FIG. 4.—THREE-PHASE TYPE CCL MOTOR.

necessary. Belt adjustment on these motors is made by tension screws, which shift the motor on a cast-iron bedplate. There are no wearing parts on the machine except the bearings, and as these are of ample dimensions with a light rotor and flooded lubrication maintained at all times by means of oil rings, the wear is exceedingly slight. The magnetic circuit consists of circular laminations of sheet steel, securely keyed into the cast-iron frame. Terminal leads are brought out at the base of the frame, held in a cast-iron cleat. Hand connectors or knuckle joints, such as are supplied with railway motors, are used to connect the motor to the supply circuit. The rotors of all CCL motors are of the squirrel-cage type. The winding consists of square copper bars lying in partially closed slots and bolted at the ends to metallic rings of ample cross-section to dissipate the heat generated in them. For the ½-h.p. motor round bars are used and are riveted to brass or copper rings at

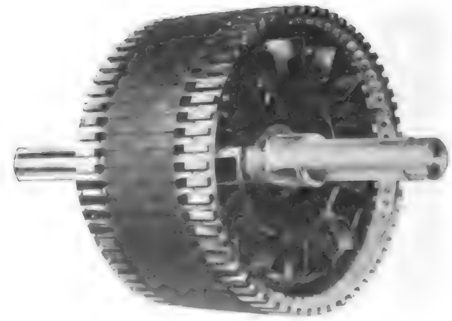


FIG. 5.—ROTOR OF TYPE CCL MOTOR.

each end. The design and principles governing the construction of these motors are particularly favorable to maintaining good efficiencies at low loads, which insure a high all-day efficiency, as in general service

motors may operate at light loads much of the time. The motors are provided with liberal bearings and shafts, and adjustment of the bearings is said to be unnecessary.

ENGINE INDICATOR AND OVERLOAD ALARM.

Fig. 6 herewith illustrates a device recently designed by J. F. Shreffler, of Chicago, Ill., the purpose of which is to give a constant reading of the load on the engine in plain figures. It is also arranged to sound an alarm should the load exceed any predetermined maximum. The indicator is permanently attached to the engine and is operated by affixing an indicating finger to that part of the valve or governing mechan-

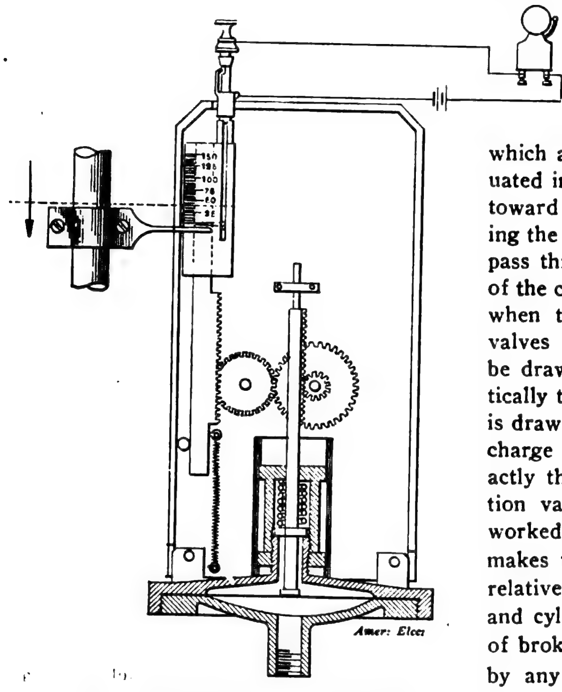


FIG. 6.—SHREFFLER ENGINE INDICATOR.

ism, such as the knock-off rod of a Corliss engine, which has a movement varying uniformly with the load on the engine. The indicating finger travels over a graduated scale, which is caused to move longitudinally as the steam pressure varies, by means of the gears shown which are acted upon by the rod in contact with the diaphragm plate at the bottom. This diaphragm is connected to the source of pressure and a connection is made at the opposite side of diaphragm to an exhaust pipe for condensing engine and those working against the back pressure. The scale plate is made movable to compensate for any variation in steam pressure and the overload attachment is fastened to it. In operation the index finger is placed at any desired figure on the scale plate. If the indicating finger moves over the scale to a point beyond the point at which the overload finger is placed, a rod is displaced, closing an electric circuit and resulting in the ringing of a bell. The scale plate may be calibrated by means of the old style card-tracing steam indicator, and when once calibrated, it is claimed, a simple test can be applied to verify or correct its accuracy due to the wear on the engine's parts.

MOTOR-DRIVEN REFRIGERATING MACHINE.

One of the new types of refrigerating machines built by the De La Vergue Machine Company, of New York, is illustrated in the accompanying engraving. These machines have been produced to satisfy a call for small and medium-sized units employed in plants which draw their power from lighting mains, and for use elsewhere where steam or other power is not available or convenient. They are driven by Morse noiseless chain belting, which allows the motor to be set quite close to the machine, so that the whole unit becomes well adapted to use where floor space is limited. The water jackets, which are of the closed type, perform the function of cooling not only the cylinder walls, but also the oil for lubricating the piston rod. One of the characteristic features of this machine is the arrangement of the valves. Both the suction and discharge valves, which are of the usual poppet type, are situated in a common chamber with their seats toward the center so that the cold gas entering the cylinder and the hot gas leaving both pass through a common port in the bottom of the cylinder. From this it is obvious that when the valve bonnets are removed the valves and springs in their housings can be drawn out of their chambers with practically the same facility that a Corliss valve is drawn out of its valve chamber. The discharge valve housings and seats are of exactly the same length and size as the suction valve housings and seats and all are worked to a system of standards which makes them interchangeable. The peculiar relative arrangement of the valve chambers and cylinder makes it impossible for pieces of broken valves to get into the cylinder if by any chance a valve should break. A further precaution is taken by making the suction valve housing split, which enables the suction valves to be made of one solid piece of metal, and without diminishing their cross-section at any point. Both suction and discharge valves are made hollow, so that their inertia is reduced to a minimum and quick opening and closing necessary for high efficiency is obtained. By utilizing the same port for suction and discharge the clearance is not only halved, but the extremes of cylinder temperature due to entering cold and discharging hot gas are tempered and the usual difficulties due to expansion and contraction are eliminated. The location of the discharge as well as the suction valves allows this type of compressor to discharge large quantities of liquid which may accidentally enter the cylinder, without the dangers incident to similar occurrences in other machines. The valve design of these small and medium-sized units is practically the same as that employed by the company on its large type of horizontal machines.

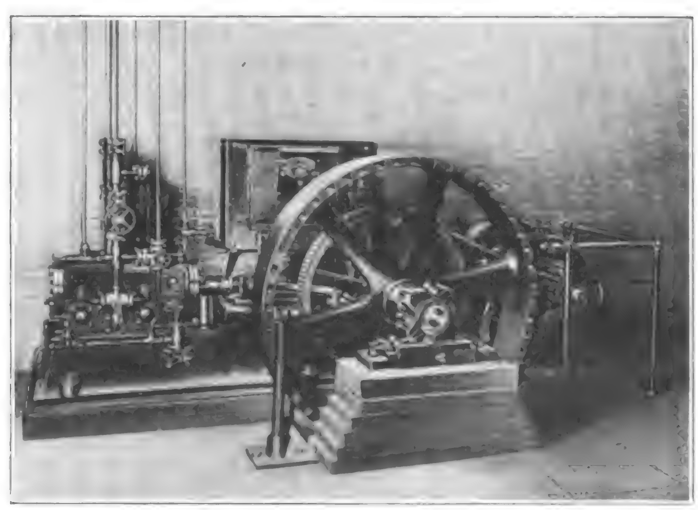


FIG. 7.—5-TON MOTOR-DRIVEN REFRIGERATING MACHINE.

IMPROVED REGRINDING VALVES.

The Lunkenheimer Company, of Cincinnati, Ohio, has made a number of improvements on its regrinding valves. The changes, however, are not at all radical. The weight has been increased, the shape altered and longer screw threads provided. All sizes of the valves now have lock-nuts on the hand wheels, which facilitates the

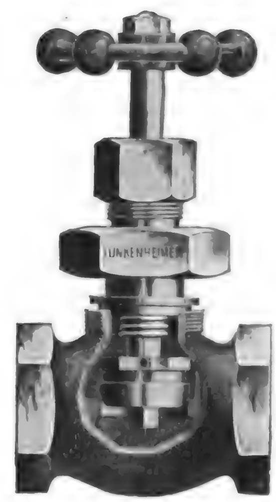


FIG. 8.—LUNKENHEIMER VALVE.

taking apart and assembling of the valve for repairs, etc. Referring to the sectional illustration, it will be noticed that the hub is secured to the body by a union connection which screws over the shell of the valve body. By means of this construction it is impossible for the hub and the body to become corroded together, as the thread which holds the union ring to the body is protected at all times from the action of the steam, the joint being made between the flange on the hub and the neck of the body. This connection also acts as a tie or binder in screwing over the body and tends to make the valve rigid and strong. The disc is held loosely to the stem by

means of a lock-nut, and therefore will adjust itself to the seat readily. The stem is fitted with a strong thread, and the manufacturers state that the valve is very easy to operate. The reason for this is that the hand wheels are so proportioned in respect to the seat opening that no additional leverage need be applied to the hand wheel to facilitate the operation of the valve. To regrind the valve the bonnet ring is unscrewed and the trimmings are removed from the body. A wire or nail is placed through the lock-nut and stem, a little powdered sand or glass and soap or oil are placed on the disc, and the trimmings are again placed in the valve and reground. The bonnet has a small rim or projection on the bottom thereof, which acts as a guide on the inside of the valve neck while regrinding. The seats on the valve-bodies are small when the valves are sent out, which permits of considerable regrinding and is considered an important feature. The valve can be packed under pressure when open or closed, and to pack while the steam is flowing through the valve the valve is opened as wide as possible, when the shoulder at the top of the stem thread forms a seat beneath the stuffing box.

A COMPACT ELECTRICAL GENERATING SET.

A new series of designs of generating sets with direct-connected compound engines has recently been placed upon the market by the B. F. Sturtevant Co., Hyde Park, Mass., of which the 100-kw. size is illustrated herewith. The new series embraces five sizes, ranging from 17½ to 100 kilowatts, which are particularly adapted for marine use or for use under conditions requiring a compact equipment. The designs were made to conform strictly to the requirements of the U. S. Navy, for which a number of sets has been built. The engine has an enclosed frame, with oil-tight doors, easily detachable for access to the moving parts within, so as to provide for splash lubrication; this is assisted by a centrifugal oil thrower at each end of the engine shaft which floods the crank pins, etc. Force feed lubrication is also provided at the other bearing parts and the rod stuffing boxes are rendered accessible from without the enclosed frame. The other features of the design indicate careful study—the high-pressure cylinder has a double-ported piston valve and the low-pressure cylinder a double-ported balanced slide valve, arranged to lift from its seat in case excessive condensation should be present. The cylinders are also protected from water by special relief valves at each end. Rites governors are used which maintain a speed regulation within 1½ per cent. from no load to full load. The 100-kw. size operates at 350 r.p.m. under the steam pressure of 150 lbs. The generator is of the multipolar engine type with compound winding and has a two-circuit armature of the ventilated drum type.

FIG. 9.—COMPACT ELECTRICAL GENERATING SET.

A special feature is to be noted in that a vertical adjustment is provided for the field frame for equalizing the air gap. The pole pieces embody a new construction of wrought iron with cast iron shoes permitting of easy removal for access to the field coils. The armature core is of a new design, which is effective in eliminating hysteresis losses and is still mechanically strong; particular attention was given to the securing of ample core ventilation. Insulation is another factor that has received careful attention, it being guaranteed damp proof and unaffected by temperatures up to 100° C. The brushes are designed for a maximum current density of 50 amperes per sq. in. of bearing surface and are staggered to equalize the wear upon the commutator. The set is subjected to rigid tests after erection, the engine being operated at overload without lagging to detect possible imperfections in the castings. The generators are designed to operate with 50 per cent. overload for short intervals and continuously at 25 per cent. overload, without sparking or undue heating. The electrical regulation secured is such that the voltage does not vary greatly when full load is thrown suddenly on or off.

SMALL VERTICAL HIGH-SPEED ENGINE.

The illustration herewith shows a small vertical engine recently placed upon the market by the American Blower Company, of Detroit, Mich., which possesses unique features of great merit. The engine is fully enclosed, preventing foreign matter getting into the working parts, yet the latter are easily accessible upon the removal of the enclosing plates, by simply turning a milled hand nut. The most remarkable feature of the engine is its oiling system. This is something entirely different from any of the usual methods. The oiling is done by the engine itself, and instead of a drop or two a minute, it is claimed that each bearing has a stream of oil. By referring to Fig. 10 the operation can be easily traced. An eccentric, *K*, on the shaft actuates the plunger, *L*, of the oil pump, *A*, forcing the

FIG. 10.—A. B. C. HIGH-SPEED ENGINE.

oil up through the tube, *B*, into the small strainer, *C*. From *C* it drops into an oil-box through the bottom of which four tubes project. In one side of each of these tubes there is a slot, so that when the oil-

box contains only a small amount of oil, each tube can take its proper proportion. In case the box is full all the tubes get more oil in proportion to the increased height. One of these tubes, *F*, and one on the opposite side, not lettered, apply oil to the guides, the oil dropping into a small oil trough, *G*, from which it runs into the bearing through an oil hole. The cross-head pin is supplied by the tube marked *E*, the oil drops into the cup, *H*, and fills the cavity between the bolt and inside of cross-head pin and the oil grooves. The oil dropping from the cross-head is caught in two pans attached to the inside of the covers. From these oil pans it runs down the inside of the cover, dropping into a cup in the top of the main-bearing cap. Instead of oil grooves at the top and bottom of the main bearing, as ordinarily made, in this system the oil is supplied at the sides where the bearing is cut away at the joint. When the strain from the connecting rod is up, the oil is carried to the bottom of the bearing, but when the load is reversed, there are no oil grooves to carry away this oil. The crank pin is oiled through the tube marked *D*. This tube discharges into a crank oil ring inside the eccentric, *K*, which in turn discharges into the crank-pin oil tube, and flows across the crank-pin bearing. The crank-pin oil ring, in addition to its independent supply, catches the drip from one end of the main bearing. The eccentric is oiled by the drip which it catches from the other end. Not the least difficulty has been experienced in catching the oil thrown off the eccentric strap and the splash from the cross-head has been equally easy to take care of, the outside of the engine being free from oil. A portion of the oil as it drops back into the bottom of the frame drops upon an oil filter and is cleaned and purified. The large base gives the oil an excellent opportunity to cool and settle. The manufacturers have been experimenting with this engine for some two years past, and in connection with their experiments relate an experience which is little short of marvelous. An engine was adjusted and filled with oil on March 10th; up to July 15th no adjustments of any character had been made, and no oil added except to fill the sight-feed cylinder lubricator. It had been operating from fourteen to sixteen hours per day driving a blower, and after the lapse of over four months really needed no adjustment or fresh lubricant, running almost as noiselessly as at first. The builders claim that they expect every engine turned out to operate in an equally satisfactory manner.

TEST OF A DE LAVAL STEAM TURBINE.

Much has been written of late regarding the probable deterioration of steam turbines after they have been in service a number of years and of the probable effect of this deterioration on the steam economy of the machine. Recent tests made by Profs. Edward F. Miller and R. R. Lawrence, of the Massachusetts Institute of Technology, on a 150-h.p. steam turbine dynamo set, which had been in use for the past two years in the plant of the New England

FIG. 1.—DE LAVAL TURBINE WHEEL.

Construction Company, will therefore, doubtless, be of interest.

The turbine was taken apart and thoroughly examined as regards to wear before the test was made, and photographs were taken of the turbine wheel, buckets and pinion, which are reproduced herewith. It will be noted that the wear on all of these parts is practically nil. This machine was installed with the following steam guarantees: 18.7 pounds of steam per b.h.p. per hour at full load, and 19.7 pounds of steam at half load, with a steam pressure of 150 pounds at the governor value and a vacuum of 26 inches at the turbine. The results of the tests show that the turbine is still within the original guarantee, thus proving that whatever deterioration may have taken place has not, to all appearances, affected the steam consumption.

The test was made June 11, continuing from 9 a. m. until 6 p. m., after which the electrical heat losses were obtained in order to determine the absolute brake horsepower. The steam supplied to the turbine for the test came from one boiler; the steam for the auxiliaries and the feed pump supplying this boiler coming from a second boiler. A steam loop was utilized to turn all condensation from the steam main leading to the turbine to the boiler. The amount of steam used was determined by measuring the feed-water. The blow-off pipe and the auxiliary feed pipe were disconnected and blanked. The steam and feed piping were both kept tight, so that there were no leakages to make allowance for, all of the water put into the boiler being used in the turbine and in the calorimeter. The feed-water was weighed in a barrel on a pair of scales sensitive to less than ¼ of a pound under maximum load. The water weighed was run into a small barrel beneath the scales and the feed was taken from this barrel. The quality of the steam was figured from readings taken on a throttling calorimeter placed near the throttle of the turbine. The time

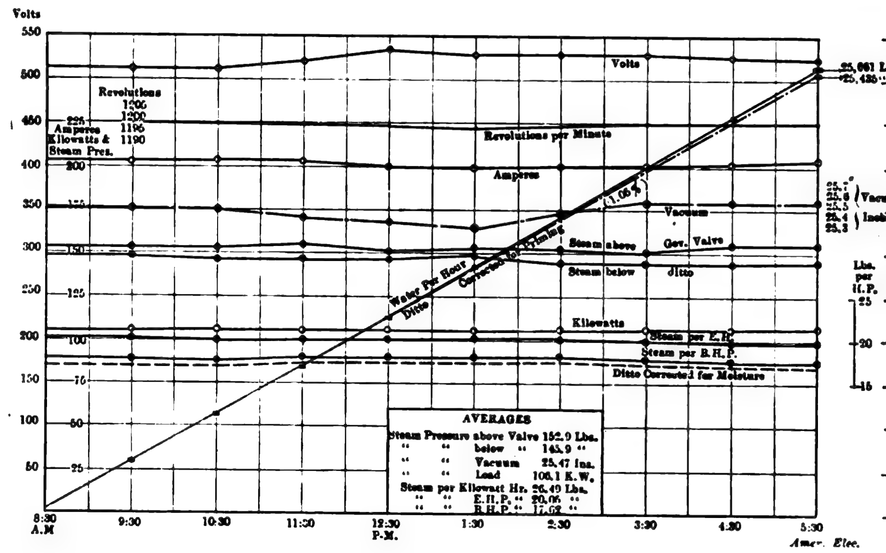


FIG. 3.—TEST OF A DE LAVAL STEAM TURBINE.

this instrument was in use was noted and the amount of steam used by it was calculated by Napier's formula. The orifice used to do the throttling was ¼ inch in diameter. Pressures were taken at the throttle and in the case supplying the nozzles. This latter pressure is beyond the governor and fluctuates with any change of load. Temperatures of the steam at these two places were taken also. It was thought that the throttling by the governor might dry out any slight amount of moisture in the steam

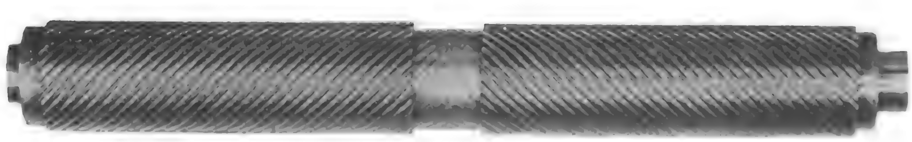


FIG. 2.—DE LAVAL TURBINE PINION.

and that the steam entering the nozzles might be slightly superheated. During this test the throttling was slight and there was but little change in the quality of the steam in passing through the governor valve. The vacuum was measured by a U-tube filled with mercury. The poorer vacuum obtained near the middle of the test was due to low water in the river.

The electrical output was absorbed in a water-cooled rheostat. The load was kept very steady throughout the test and the necessary electrical instruments were inserted for measuring the power. Previous to the test the turbine had been running 45 minutes. The results of the test are tabulated below:

Duration of test, hours	9
Boiler pressure gauge, lbs.	152.9
Boilure pressure below governor valve, lbs.	145.9
Number of nozzles in use	6
Quality of steam, priming per cent	1.05
Barometer, inches	29.90
Vacuum, inches	25.47
Average volts, dynamo No. 1	262.7
Average volts, dynamo No. 2	262.1
Total amperes	202.0
Average total kw. output	106.1
Average total E. H. P. output	142.2
Average total B. H. P. input	160.4
Average number of revolutions per min.	1,200.0
Total steam used for nine hours, lbs.	25,661
Average steam per hour, lbs.	2,851.0
Average steam per hour, corrected for moisture, lbs.	2,826.0
Steam per kw.-hour, lbs.	26.49
Steam per E. H. P. hour, lbs.	20.05
Steam per B. H. P., hour, lbs.	17.77
Steam per B. H. P. hour, corrected for moisture, lbs.	17.62

THE ELECTRICAL COMPRESSOR PLANT IN THE CHICAGO & NORTHWESTERN RAILROAD TERMINAL.

The air power plant at the Chicago terminal station of the Chicago & Northwestern Railroad is a typical example of the best modern practice in the application of electric power to the compression of air for the many purposes of railroad yard work.

The plant is located in a small brick building to the rear of the station, close to the river and adjacent to the extensive passenger yards of the company. This building comprises two rooms, in one of which is located the electrical and pneumatic apparatus.

Alternating current is taken from the main of the Chicago Edison Company and passed through transformers, reducing it to the working voltage. Part of it is used directly on low-voltage alternating circuits, and the remainder is passed through rotary converters or motor generators and delivered as direct current for power purposes.

The air compresser plant is made up of two Ingersoll-Sergeant standard power-driven compressors, of the type designated by the makers as Class "JC." They are duplex two-stage machines, with air cylinders, frames, and bearings, mounted on a solid cast-iron bed-plate, which encloses the horizontal inter-cooler between the cylinders. Both high and low-pressure cylinders are fitted with the standard Ingersoll-Sergeant piston inlet valve, and regulation is secured by a standard choking controller on the low-pressure intake. This device, acting to throttle the air intake passage, is controlled by receiver pressure and automatically regulates the volume of air compressed and consequently the amount of power consumed—to the demand for air from the power system. The compressors run at constant speed, the controller simply varying the effective piston displacement with varying load. The machines have a stroke of 12 inches, with air cylinders 12¼ and 18¼ inches in diameter. At a speed of 130 r.p.m. the free air capacity of each unit is 455 cubic feet per minute. The pressure used in this plant is 70 to 80 lb. gauge.

The sub-base is extended in each compressor to support the driving motors, which are General Electric direct-current machines, rated at 80 horse-power on 220 volts and having a speed of 510 r.p.m. A pinion on the motor-shaft gears directly with the teeth on the compressor fly-wheel, which is of standard weight for machines of this capacity. The gears are protected by proper guards.

Independent concrete foundations are used. Each unit has its own automatic oiling system, fed from a central tank. The drip is recovered and filtered. Sight-feed oilers care for cylinder lubrication. Fig. 1 shows one of the units, of which there are two in operation. An intake duct, supplying both compressors, leads under the floor to the open air and rises beside the power-house, terminating in a screen cover for the exclusion of dust and cinders from the yards.

The discharge pipes from the two units feed an air main leading to the primary receiver outside the plant. Provision is made for draining this receiver. From this point, the line leads to a system of cooling tubes to the west of the power-house, made up of a large upper and lower horizontal header, connected by a number of small vertical pipes. This arrangement, freely exposed to the air, precipitates whatever moisture may remain in the air after leaving the primary receiver; and this water is withdrawn from the lower header. From this cooler, air lines radiate throughout the yard, supplying power to the pneumatic switch and signal system controlling the movement of trains in the terminal track system. Secondary air receivers are also located at suitable places. The air is used almost entirely in this system for switches and signals; but a small portion is diverted to the boiler room, where it is applied in a small air-lift pumping outfit which supplies water to the terminal.

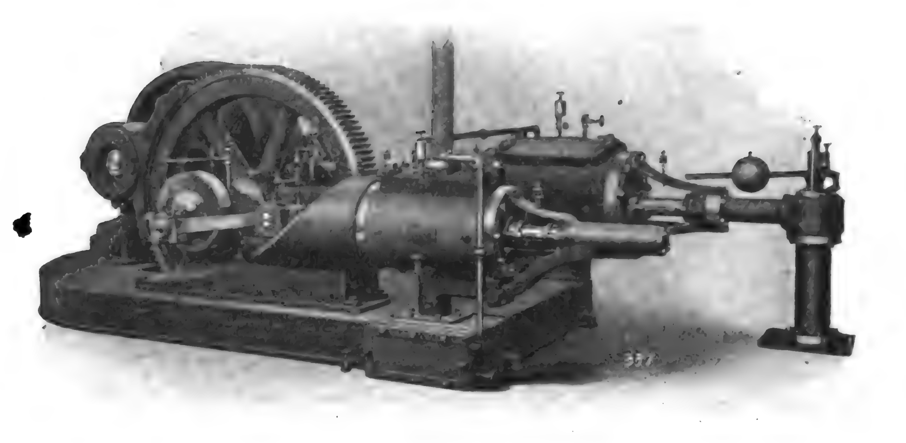


FIG. 1.—MOTOR-DRIVEN AIR COMPRESSOR.

TESTS ON A 2000-KW. CURTIS STEAM TURBINE.

Tabulated below are the results of tests made by Louis Ferguson of the Commonwealth Electric Company, of Chicago, and F. Sargent, of Sargent & Lundy, on a 2,000-kw. Curtis steam turbine at Schenectady, N. Y., on May 3, 1905. The turbine is a four-stage machine designed in 1903 and recently changed in a few particulars as a result of experiments conducted during the past year. The machine conforms as nearly as possible to the standard four-stage machines now being produced, but the builder claims that it is less efficient since the changes made were confined to the buckets, while several other changes, which were desirable, could not be made without entirely rebuilding the machine. All of the instruments used during the test were carefully tested and standardized in New York. The surface condenser used showed practically no leakage, and every precaution was said to be taken to make the test reliable and accurate. The results obtained were as follows:

Full-Load Test:

Duration of test	1.25	hour.
Steam pressure (gauge)	166.3	lbs.
Back pressure (absolute)	1.49	in. of mercury.
Superheat	207.	deg. F.
Load in kilowatts	2023.7	
Steam consump. per kw.-hr.	15.02	lbs.

Half-Load Test:

Duration of test	0.916	hour.
Steam pressure (gauge)	170.2	lbs.
Back pressure (absolute)	1.40	in. of mercury.
Superheat	120.	degrees F.
Load in kilowatts	1066.7	
Steam consump. per kw.-hr.	16.31	lbs.

Quarter-Load Test:

Duration of test	1.	hour.
Steam pressure (gauge)	155.5	lbs.
Back pressure (absolute)	1.45	in. of mercury.
Superheat	204.	degrees F.
Load in kilowatts	555.	
Steam consump. per kw.-hr.	18.09	

Zero Load:

Duration of test	1.33	hours.
Steam pressure (gauge)	154.5	lbs.
Back pressure (absolute)	1.85	in. of mercury.
Superheat	156.	degrees F.
Steam consump. per kw.-hr.	1510.5	lbs.

CROCKER-WHEELER ELECTION AND DIVIDEND.

The officers of Crocker-Wheeler Co., Ampere, N. J., have been re-elected for the ensuing year. The officers are Dr. Schuyler Skaats Wheeler, president; Gano S. Dunn, vice-president and chief engineer; W. L. Brownell, treasurer; G. W. Bower, assistant treasurer. The directors are Prof. Francis B. Crocker, Dr. Wheeler, Messrs. Dunn, Doremus, A. Foster Higgins, Herbert Noble, Thomas Ewing, Jr., F. L. Eldridge and C. A. Spofford. The regular quarterly dividend of 1½ per cent. has been declared and the affairs of the company are reported as being in a flourishing condition.

ELECTRIC LIGHTING AND POWER UNITS FOR EXPORT.

The B. F. Sturtevant Co. has for years made a specialty of high-grade generating sets, with the engine and generator designed each for he other, and combining high efficiency with small space and weight—elements which are particularly essential in machinery built for export. This company now catalogues thirty-six different sizes and types of units ranging from 3 to 100 kw. Each is absolutely complete, and is carried upon a bedplate common to both members of the set. The size and weight of all but the larger sizes are such as to permit of export shipment without the separation of parts, so that the machine stands ready for operation as soon as it is unpacked.

The Sturtevant Company recently made an interesting and somewhat unusual application of induced draft in the plant of the Cleveland Paper Manufacturing Company, Cleveland, Ohio. A special engine-driven fan was installed to produce draft for two horizontal return tubular boilers of 200 horse-power, and force the products of combustion under two other boilers which serve as feed-water heaters or economizers.

A LARGE AUTOMATIC TELEPHONE EXCHANGE.

The Automatic Electric Company recently closed a contract of considerable interest to telephone men. It is for a 15,000 line automatic telephone system for Havana, Cuba. This is to displace the old "Red Telefonica System" of Havana, formerly owned by a Spanish company but now a part of the properties of the Cuban Telephone & Telegraph Company. The latter company has also contracted with the Automatic Electric for a 600 line automatic system for the town of Marianao, Cuba, a suburb of Havana. The initial installation at Havana will be for 5000 lines.

The cosmopolitan character of Havana's population makes the automatic system peculiarly well adapted for use there; it would be necessary for telephone operators to be fairly good linguists in a city of so many nationalities.

Two other contracts recently granted the Automatic Electric Company were for a 250-line exchange at Miamisburg, Ohio, for the Montgomery County Telephone Company, and a 1200-line exchange for the Dakota Central Telephone Company at Aberdeen, South Dakota. These two exchanges will be the first to have the new automatic four-party lines with selective ringing and lockout recently worked out by the company's engineers. This new development of the automatic system attracted much attention at the recent Independent Telephone Convention in Chicago, where it was exhibited for the first time.

THE HAVANA CENTRAL RAILWAY SYSTEM.

The Havana Central Railway Company, Havana, Cuba, has placed orders with the Foreign Department of the General Electric Company, of Schenectady, N. Y., for complete electrical equipment of a net work of interurban electric railway lines radiating from Havana and covering an extensive territory inland. The system will include a central power house in Havana and eight outside sub-stations, together with line material for about 125 miles of trackage and rolling stock for passenger and freight service over the entire system.

The power house in Havana will furnish 5000 kilowatts at 19,000 volts and 25 cycles; three-phase alternating current generators and Curtis steam turbines will be used. The generator e.m.f. of 2200 volts will be stepped up by air-blast transformers to the line voltage. The transmission lines will parallel the various lines of the railway to the sub-stations where step-down transformers will supply rotary converters furnishing 600-volt direct current to the trolley lines and feeders.

From Havana one branch will run southeast through Cuatro Caminos, Lomas de Candela, Guines and Providencia to Rosario, a distance of about 40 miles. Sub-stations will be located at Cuatro Caminos, Lomas de Candela and Providencia. A second line will run from Havana 17 miles south to Bejucal with a sub-station on the line at Santiago de las Vegas. A third line running southwest from Havana to Mariel will have a length of 37 miles and branch lines running north and south to El Carmelo, Santiago de las Vegas and Tuira de Malena amounting to about 30 miles in addition. Sub-stations on the line to Mariel will be located at Marianao, Hoyo Colorado, Guanajay and San Antonio Melena.

The rolling stock for passenger service will consist of twenty-four 30-ton cars, each seating 50 passengers and equipped with four GE-74 motors geared for a maximum speed of 40 miles an hour. The freight service will be handled by ten 40-ton General Electric locomotives equipped with four GE-55 motors geared for a speed of 17 miles an hour when hauling a 300-ton train.

The entire system will have double overhead trolley both in Havana and on the interurban lines. The high potential transmission lines will be designed for a future potential of 30,000 volts to provide for extensions. The transformers in the Havana power house and in the sub-stations are also to be suitable for use at the increased potential.

CRANE COMPANY'S 50th ANNIVERSARY.

The Crane Company, Chicago, celebrated its fiftieth anniversary on July 4th; all of the company's branch house managers took part in the celebration. The branch house managers went all through the factories and were given a dinner and taken to the "White City," where an evening was spent visiting places of entertainment. A trip was also made to Lake Geneva, Wis., where they were entertained by Mr. R. T. Crane at his summer residence, and on July 6th the company gave to all its employees and their families a picnic at North Western Park. About 10,000 people attended this picnic.

A brief history of the Crane Company will doubtless be of interest. In the spring of 1855 Mr. R. T. Crane came to Chicago and established a brass foundry in a corner of his uncle's lumber yard. The first "heat" was taken off on the Fourth of July. The sand used was found on the premises, and the first castings were couplings for connecting lightning rods. Business prospects looking good, Mr. Crane sent for his brother, Charles S. Crane, and shortly after his arrival the firm decided to go into the making and finishing of brass goods. A foot lathe was purchased, and the manufacture of brass engine trimmings begun. A few months later a room with power was rented, and the following spring a small three-story frame building was erected and equipped for power with a 6-h.p. portable engine. The next year jobbing in wrought-iron pipe and fittings and steam warming work was taken up.

After the breaking out of the civil war the enormous demand of the government for all sorts of material created a boom; soon the brass plant had to be enlarged, and the manufacture of brass globe valves, check valves, steam and gas cocks was begun. An iron foundry was started, and the building, in a small way, of machinery and the making of a few articles in the steam fitting line was undertaken. About the same time a small butt-weld pipe mill, the first mill west of Pittsburg, was built on ground where the Crane Company still has a pipe mill. In the same year ((1864) the property where the present brass department is located, No. 10 North Jefferson Street, was purchased and the first malleable iron foundry outside of the Eastern States started. This foundry was on the second floor and is said to be the first instance of a foundry being located above the ground floor. The manufacture of both malleable and cast-iron fittings was commenced, and in connection with the fitting business the company early took up the manufacture of dies and die plates.

In 1865 the business was incorporated by Richard T. Crane, Charles S. Crane, Martin Ryerson, Eliphalet W. Blatchford, Charles N. Holden, and the name changed from R. T. Crane & Bro. to the Northwestern Manufacturing Company. This name was retained until 1872, when the title Crane

Bros. Manufacturing Company was adopted, which was changed in 1890 to Crane Company. By 1870 the business had grown so that further extensions were necessary. The land west of the property at No. 10 North Jefferson Street was purchased and a building erected thereon. Fortunately the company escaped the big fire of 1871, and the large increase that had recently been made in facilities enabled the company to take advantage of the heavy demand for goods created in the rebuilding of the city. In 1881 another pipe mill was erected on property purchased on West Twelfth Place where there were excellent railroad facilities. One lap-weld and two butt-weld furnaces were erected.

Although the Crane Company was concentrating upon the manufacture of valves and fittings, the continued growth of the business demanded extensive additions in 1891, 1899, 1900, 1902, 1903, and this year a five-story modern office building has been erected. Not only has there been an immense increase in the floor space used for manufacturing purposes, but all departments have been equipped with the latest improved machinery, much of which has been designed and built by the company.

The company has constantly added to its lines of manufacture. Some of the important classes of goods put on the market in more recent years have been stationary, marine and locomotive pop safety valves, drainage fittings, extra heavy brass and iron valves and fittings, hydraulic valves and fittings, ferro-steel flanged fittings and valves, ammonia fittings, steam traps, steam and oil separators, malleable and ferro steel companion flanges, electrically and hydraulically operated and steam actuated valves, and a complete line of flat band fittings. In addition the company is prepared to turn out complete piping equipments for power plants, and has facilities for bending and threading all sizes of pipe, and screwing, welding and rolling flanges on it. All told, the Crane Company manufactures more than 10,000 articles for use in connection with steam, water, gas or air.

NEW BOOKS.

MODERN ELECTRICAL CONSTRUCTION. By H. C. Horstmann and V. H. Tousley. Chicago: Frederick J. Drake & Co. Flexible leather; 242 pages, 4 ins. x 6½ ins.; 138 illustrations. Price, $1.50.

This is a rather skillful combination of an explanation of the Fire Underwriters' rules and an exposition of the elementary features of electrical engineering. The authors describe batteries, bells, dynamos, lightning arresters, etc., etc., and explain the application of the Underwriters' Rules to the installation of such apparatus. The book is liberally illustrated and should be extremely useful to practical workers in the electric lighting and power field.

ELECTRICAL INSTRUMENTS AND TESTING. By Norman H. Schneider. New York: Spon & Chamberlain. Cloth, 199 + xvi pages, 5 ins. x 7½ ins.; 105 illustrations. Price, $1.00.

This little book embodies a commendable effort to present in simple language the elementary features of electrical testing, and the author has succeeded so well as to disarm any unhardened critic who might find occasion to comment unkindly on the diction and methods of exposition. The statements, so far as the reviewer has analyzed them, are accurate, and the arrangement of the contents logical. After describing the usual instruments employed in testing circuits, the author explains all the ordinary tests that are needed in the general run of work. The book is excellent.

AMERICAN TELEPHONE PRACTICE. (Fourth Edition.) By Kempster B. Miller. New York: McGraw Publishing Company. Cloth, 888 + xvi pages, 6½ ins. x 10 ins.; 643 illustrations. Price, $4.00.

This edition of Mr. Miller's excellent book shows evidence of exhaustive revision and leaves very little to be desired. The old chapters have been practically rewritten, and much new material has been added, notably discussions of common battery systems, the divided multiple system, private branch exchanges, party lines, meter service, and power plants for common battery systems. The book has an enormous scope, so that criticism of any failure to cover features of minor importance might seem captious; it is to be regretted, however, that the different systems of exchange and subscribers' instruments and connections could not have been shown in complete elemental form in each case; except for this, one would need to exert oneself abnormally to find an excuse for adverse comment. The book must prove invaluable to telephone engineers and others actually interested in telephone exchange work.

GAS ENGINE DESIGN. By Dr. Charles E. Lucke. New York: D. Van Nostrand Company. Cloth; 254 + viii pages, 6 ins. x 9 ins.; 145 illustrations. Price, $3.00.

Dr. Lucke is one of the few college professors whose practical engineering abilities have developed along with their technical academic education, and as a consequence the present work is a superb one. The book is restricted to the quantitative side of gas engine design and construction, and contains an immense amount of valuable data collected from practice as it has developed during the past several years. Beginning with a discussion of power, efficiency and economy, the author briefly develops the formulas giving the relations between indicated horse-power, mean effective pressure, cylinder dimnesions, piston speed, explosions per minute and piston displacement, for two-stroke and four-stroke cycle engines; gives a standard reference (indicator) diagram based on adiabatic compression and expansion, explains fuel characteristics and the ratio of actual to ideal pressures during a cycle, and gives a great deal of practical data and many useful formulas. The next section is devoted to the forces in a gas-engine cylinder due to gas pressure and inertia. Some actual indicator cards are presented and discussed, and the relation between the reciprocating parts and kinetic forces is taken up in refreshing detail. The final section contains an elaborate discussion of engine parts (weights and dimensions). A detailed review of the work is impracticable, owing to the thoroughness with which it has been carried out; such a review could easily grow into a small volume, most of the contents of which would be commendatory. The only serious fault noticed by the reviewer is slovenly diction; the rather reckless use of the letter *C* as a symbol is greatly inconvenient to the reader, but it scarcely attains the magnitude of a defect.

PERSONAL.

MR. FRED STADELMAN has been appointed assistant manager of the New York office of The Wellman-Seaver-Morgan Company.

MR. B. H. WARREN, president of the Allis-Chalmers Company, has just returned from an extended European trip, arriving on the *Baltic*, July 20.

MR. FRANCIS RAYMOND has severed his connection with the Stanley-G. I. Electric Manufacturing Company to re-enter the field as manufacturer's agent.

MR. ROBERT C. REED has been appointed superintendent of the electrical department of the Duquesne Steel Works of the Carnegie Steel Company.

MR. W. A. STADELMAN, heretofore eastern agent of The Wellman-Seaver-Morgan Company, with headquarters in New York, has been appointed general sales agent of the company, with headquarters at Cleveland, O.

MR. M. B. BEATTIE, formerly connected with the power and mining department of the General Electric Company, has recently resigned his position there to accept one with the Chicago office of the Crocker-Wheeler Company.

MR. ARTHUR WILLIAMS, of the New York Edison Company, recently sailed for Europe for a rest of a few months. While abroad Mr. Williams will look very thoroughly into the municipal ownership situation on the other side.

MR. HARRY V. CROLL, for the past eight years with the E. P. Allis Company and its successor, the Allis-Chalmers Company, of Chicago, has resigned to accept a position with The Wellman-Seaver-Morgan Company, of Cleveland, O.

MR. A. H. WHITESIDE, who has for a considerable time been manager of the Allis-Chalmers Company's district office at Atlanta, Ga., was transferred, on July 15th, to the Philadelphia district office, where he succeeds Manager W. A. Wood, resigned.

MR. W. J. BUCKLEY, who has earned an enviable reputation as a salesman of electrical machinery in the Southwest, has been appointed manager of the Allis-Chalmers Company's district office at St. Louis. Mr. H. P. Hill, whom he succeeds, goes to the Salt Lake City district office, where he will devote his energies to the electrical branch of the company's business.

MR. M. W. THOMAS has been appointed manager of the Allis-Chalmers Company's district office at Atlanta, Ga. Mr. Thomas is widely known in the South, where he has been identified for years with electrical and machinery interests. He was until recently manager of the Westinghouse Electric & Manufacturing Company's office in New Orleans and brings to the Allis-Chalmers Company the advantage of a very large and valuable acquaintance.

MR. HAROLD U. WALLACE, son of Mr. John F. Wallace, who recently resigned the chief engineership of the Panama Canal Commission, has accepted the third vice-presidency of J. G. White & Co., New York. Mr. Wallace resigns as chief engineer of the Illinois Central Railroad to accept this position. He has been connected with that road since 1894, and since 1902 has been its chief engineer. Among important work carried

out for the Illinois Central Railroad by Mr. Wallace was the lake front improvement work at Chicago. This work included the depression and reconstruction of twenty miles of main lines and yard tracks. In securing the services of so distinguished an engineer as Mr. Wallace, the White Company is simply following out its uniform policy. It has of late secured the services of several eminent engineers and it has made its recent selections largely from the steam railroad field.

MR. W. M. PROBASCO has resigned as assistant to the president of the McGraw Publishing Company to accept the office of vice-president of the Search Light Publishing Company. The latter company owns a file of about 2,500,000 clippings, articles and pictures on all subjects, compiled from newspapers, magazines, engineering journals, books and reports of scientific societies, and has a carefully organized force by which this information is classified and kept up to date for the use of publishers and others who require prompt and up-to-date information on any subject. In addition, the company publishes a weekly paper, called *The Search Light,* which is a record of the most important events of the previous week and which covers some sixty separate departments. As a nucleus for this paper the company purchased *The Great Round World* and *The Week's Progress,* publications somewhat on the line of its own, but has improved on their plans and especially in the completeness with which the information is compiled and indexed. Mr. Probasco is well known in electrical circles and his many friends will wish him success in this new departure.

TRADE PUBLICATIONS.

SUNBEAM REFLECTOR LAMPS. Sunbeam Incandescent Lamp Company, Chicago, Ill.—This is Bulletin No. 11, containing an illustrated description of the Sunbeam reflector lamp, which is made in sizes ranging from 6-c.p. to 36-c.p.

A TALK ON ARC LAMPS. The C. J. Toerring Company, Philadelphia, Pa.—Bulletin No. 6, containing an interesting discussion on the well-known Toerring enclosed arc lamp. The bulletin is well illustrated and the argument convincing.

PREPAYMENT WATTMETERS. Fort Wayne Electric Works, Fort Wayne, Ind.—Publication No. 5008 and Bulletin No. 1066 devoted to the prepayment form of alternating current wattmeters which was described in the June number of this journal.

SMALL DIRECT-CONNECTED DYNAMOS. Crocker-Wheeler Company, Ampere, N. J.—Bulletin No. 55, containing a brief description of a line of dynamos ranging from 1½ to 28 kilowatts and designed for direct connection and consequently slow speed.

DOSSERT SOLDERLESS CONNECTORS. Dossert & Company, New York.—This is catalogue No. 1, containing a description of the a brief explanation of the prinicple on which Dossert wire and cable connectors and taps, with these devices are based.

RENOLD ROLLER CHAIN. The Link-Belt Engineering Company, Philadelphia, Pa.—This is booklet No. 54, containing an illustrated description of a roller chain provided with special bushings and anti-friction rollers and intended for operation on ordinary sprockets.

EVERBEST MAGAZINE. Ewing-Merkle Electric Company, St. Louis, Mo.—This is the July number of this clever little publication and contains, in addition to interesting non-partisan reading matter, advertisements of the principal specialties handled by the publishers.

SMALL SPRINGS. The Wallace Barnes Company, Bristol, Conn.—This is catalogue No. 4, devoted to the line of small steel springs manufactured by this company. The line includes springs of every conceivable type and shape. The catalogue is superbly executed and profusely illustrated.

TRANSFORMERS. Stanley-G. I. Electric Manufacturing Company, Pittsfield, Mass.—Bulletin No. 249, devoted to "Type Z" transformers, which are of the shell type and built in sizes ranging from ½ to 30 kilowatts. The bulletin is profusely illustrated and the transformer is thoroughly described.

ELECTRICAL SPECIALTIES. The Yost Electric Manufacturing Company, Toledo, O.—A handsomely executed catalogue, slightly smaller than standard size and containing well-illustrated descriptions of Yost specialties, which include the well-known lamp sockets, receptacles, rosettes, lamp cord adjusters, shades, etc.

"A B C" FANS AND BLOWERS. American Blower Company, Detroit, Mich.—Catalogue No. 180 and folder No. 66. The former is devoted to exhaust fans of the paddle wheel type and the latter to disc or propeller-type ventilating fans driven by electric motors. Both publications are executed in the artistic style customarily employed by the company.

ELECTRIC SIGNS. A. C. & M. L. Felkin Company, Boston, Mass.—This is a catalogue of electric signs containing an illustrative description of the Imperial electric signs made by this company. These signs are of the general class in which transparent letters are employed, this being illuminated by incandescent lamps on the inside of the sign structure.

DE LAVAL WORKS AND PRODUCTS. De Laval Steam Turbine Company, New York and Trenton, N. J.—Bulletin No. 10, containing a profusely illustrated description of the De Laval factory, in which the well-known turbines and pumps are built, together with illustrations and descriptions of some of the turbine parts, processes of manufacture, etc.

KOERTING GAS ENGINES. De LaVergne Machine Company, New York.—This is the 1905 catalogue devoted to the Koerting two-stroke cycle gas engine and also containing illustrations of the Koerting four-stroke cycle engine and the Hornsby-Akroyd oil engine built by the De La-Vergne Company. The catalogue is liberally illustrated and handsomely executed.

DIRECT-CURRENT MOTORS AND DYNAMOS. Stanley-G. I. Electric Manufacturing Company, Pittsfield, Mass.—Bulletin No. 145, containing a detailed description of the "Type L" direct-current motors and dynamos built by this company. This line of machines ranges from ¼ to 15 horse-power in motor ratings and corresponding generator ratings. The description is illustrated and the bulletin is well executed.

BUSINESS NEWS.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY has removed its Los Angeles office from the Trust Building to No. 527 South Main Street.

AMERICAN ELECTRICAL HEATER COMPANY, Detroit, Mich., has established an eastern branch at 35 Dey Street, New York, in charge of Mr. B. H. Scranton. A warehouse will be maintained here, in which a full stock of standard goods will be carried.

CROCKER-WHEELER COMPANY, Ampere, N. J., has just received an order through its New York office for two engine-type generators of 105 volts and 10,000 amperes for use in the electrolytic treatment of ores. These machines will have 22 field magnet poles and will run at 100 r.p.m.

CHARLES R. UNDERHILL, New York, announces that he is now in a position to supply the trade with all kinds of small electro-magnets, induction coils, spark coils, and coil windings of every description, and in any quantity, in addition to the large electro-magnets and solenoids which have heretofore been his specialty.

CHANDLER & TAYLOR COMPANY, Indianapolis, Ind., reports that it was the successful bidder for a high-speed, self-oiling, direct-connected engine to be installed in the new power plant of Mandel Brothers, Chicago. The contract was secured in keen competition with other representative manufacturers, and the Chandler & Taylor Company naturally feels much gratification upon receiving the award.

A. L. IDE & SONS, Springfield, Ill., report among recent sales of Ideal engines the following: Wilkes-Barre Gas & Electricity Company, two direct-connected units: Hackensack Water Company, one direct-connected unit; Compania Exportadoes Coahuilente, one belted engine; City of New York, for Williamsburg Bridge, three direct-connected, cross-compound units; Anglo-Chilean Nitrate & Railway Company, one belted engine; Edison Electric Illuminating Company, three special engines to operate blowers.

THE NEW JERSEY ASBESTOS COMPANY, of Camden, N. J., reports increased activity in all departments, and is particularly gratified at the reception accorded the new high pressure packing. In the South the company's business has increased to such an extent as to render it necessary to open a branch office at Birmingham, Ala. Mr. James J. O'Rourke, who was for a long time connected with the Southern Railway Company, and who is well and favorably known to both railway and supply men, as well as to the trade in general, has been appointed manager of the Birmingham office.

JAMES McCREA & CO., Chicago, manufacturers of the "Climax" steam joint clamp for repairing leaks where pipes are screwed into fittings, and the "Emergency" pipe clamp for repairing splits and rust-holes on pipes, have just applied for a patent for a novel device in the way of a clamp for stopping leaks between pipe flanges. Every engineer has experienced difficulty with leaks of this kind occurring when it was impossible to shut down to renew packings, or when the flanges were in some inaccessible place where they could not be repacked without great expense and trouble.

THE ABNER DOBLE COMPANY, San Francisco, has secured the contract for the machinery to be installed in an addition to the hydro-electric plant of the Cramer Electric Company, at Hailey, Idaho. This contract covers the entire outfit of hydraulic and electrical machinery and apparatus and includes a 400-kw. alternator direct-driven by an 800 horse-power set of water-wheels, with exciter and governor; a three-panel marble switchboard; two 25-light arc transformers and 50 arc lamps, with regulators and other accessories; 14 transformers and supplies for the distribution system.

G. M. GEST, of New York and Cincinnati, has been awarded a contract for the construction of a complete underground conduit system at Washington, D. C., for the Western Union Telegraph Company. The conduits will be constructed of specially made steel pipe, instead of clay, and will connect all of the Western Union Telegraph Company's offices as well as the department buildings in and around Washington. Mr. Gest has also been awarded a large contract in New Orleans for the extension of the subway system of the Cumberland Telephone & Telegraph Company. This is an extension to the original system which he installed several years ago.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY., Rochester, N. Y., reports having closed a contract with the Kinlock Telephone Company, St. Louis, Mo., for a new central energy lamp line multiple switchboard of 17,000 lines capacity for the main exchange. The contract calls for an "A" board of thirty-seven sections, a "B" board of ten sections, three monitor sections of two operators' positions each, one observation desk of four positions, one combination manager's and assistant manager's desk, one combination chief and assistant chief operator's desk and one two-position wire chief's desk. The company also reports having closed a contract with the North State Telephone Company, High Point, N. C., for a 1200 line capacity, generator-call, visual signal switchboard, and one with the Anderson Telephone Company, Anderson, S. C., for an 1800-capacity lamp line signal multiple switchboard.

ALLIS CHALMERS COMPANY has begun the great extensions to its already large works at West Allis, Milwaukee. The company has awarded contracts for the structural steel, erected in place, for three of the new buildings, requiring approximately 6800 tons of steel; and for the structural steel, erected in place, for the foundry and pattern storage buildings and erecting shops, comprising approximately 4000 tons of steel. The company expects to occupy its new works on or before next March. Some idea of the size of the works when extended will be afforded by the fact that the company's present floor space at West Allis, Milwaukee, has a total area of 652,000 square feet, and the new extensions upon which work is now in progress will add 861,000 square feet, more than doubling the present floor space and making the total at the West Allis Works 1,513,000 square feet of floor space. The plant will be capable of affording employment for 11,000 persons.

Exhibits at the Electrical Contractors' Convention.

THE TIPLESS LAMP COMPANY, New York, sent Mr. R. S. Carrick to represent them.

THE HART & HEGEMAN MANUFACTURING CO., Hartford, Conn., was represented by President A. H. Pease, who was a visitor at the convention and exhibition.

THE GOULD STORAGE BATTERY COMPANY, New York, was represented at the convention by Mr. Wm. S. Gould.

MEITZ & WEISS COMPANY, New York, had a large display of their oil engines in charge of F. E. Davis, New England agent.

JOHNSON & MORTON, Utica, N. Y.—W. H. Morton, secretary of the N. E. C. A., represented his company at the convention.

THE TRAY PLATE BATTERY COMPANY, Binghamton, N. Y., had Mr. H. B. Oakman as their representative at the convention.

ECONOMICAL ELECTRIC LAMP COMPANY, New York, had n exhibit of their turn-down lamp. Mr. W. K. Abely was in charge of the exhibit, assisted by C. F. Murphy.

COUCH & SEELEY COMPANY, Boston, had a most attractive exhibit of their line of telephones. Mr. E. B. Seeley, manager, and F. C. Redfield were in charge.

THE RENIM SPECIALTY COMPANY, Boston, showed a full line of samples of its switch and outlet boxes, cut-out cabinets and trims. Miner Robinson was in charge.

MANHATTAN ELECTRICAL SUPPLY COMPANY, New York, had a very tasteful booth in which to entertain its friends. Mr. J. W. McDowell was in charge.

in carbon that is used for electrical purposes. The exhibit was in charge of J. C. Irvine and A. C. Henry.

THE WORCESTER ELECTRIC MANUFACTURING COMPANY, Worcester, Mass., had an attractive booth showing samples of its line of switches. Mr. James McGrady was busy explaining the good points.

COOLEY GENERAL DEVELOPMENT COMPANY, Jamaica Plain, Mass., had on exhibition a number of the Cooley engines of different sizes. J. F. Cooley, D. Wood and Andrew Rhoades represented the company.

THE SIMPLEX ELECTRICAL HEATING COMPANY, Cambridgeport, Mass., made a fine display of their electrical cooking and heating apparatus. C. W. Richards and A. W. Doe were in charge of the exhibit.

THE AMERICAN ELECTRIC SIGN COMPANY, Boston, had on exhibition samples of its time switches, advertising mirrograph, flashers and signs of every description. J. L. Russell, C. M. Borden and C. I. Wetmore were present.

GENERAL VIEW OF THE MAIN EXHIBITION HALL, NATIONAL ASSOCIATION OF ELECTRICAL CONTRACTORS.

THE JOHNS-PRATT COMPANY, Hartford, Conn.—Mr. E. B. Hatch and Joseph Sachs represented their company at the convention.

MUNDER ELECTRIC COMPANY, Springfield, Mass.—Mr. Charles Munder attended the convention in the interest of his company.

DOSSERT & CO., New York, made an attraction of their solderless joints. M. R. Jarvis and R. A. Bristol represented the company.

HART MANUFACTURING COMPANY, Hartford, Conn., was represented by Mr. H. A. Hart and F. B. Smith, New England representatives.

DIEHL MANUFACTURING COMPANY, Elizabethport, N. J.—Mr. B. C. Kenyon, president, represented his company at the convention.

HOLTZLER-CABOT COMPANY, Boston, made a large and very attractive display of their several lines. Mr. E. W. Schildknecht had charge of the exhibit.

H. T. PAISTE COMPANY, Philadelphia, had an attractive display of their line of specialties in charge of E. A. Jenkins, C. K. Hills and Geo. MacElwee.

THE ALPHADUCT MANUFACTURING COMPANY, New York, had an attractive space filled with samples of alphaduct flexible conduit, in charge of Russell Dart, Jr.

HARVEY-HUBBELL, INC., Bridgeport, Conn.—H. W. Bliven, sales manager, was in charge of their exhibit. The newest device shown was their porcelain wireless cluster.

D. & W. FUSE COMPANY, Providence, R. I., had an attractive show board filled with samples of its line of fuses. W. S. Sisson was a very busy representative of this company.

ELECTRO-DYNAMIC COMPANY, Bayonne, N. J., had an attractive booth with samples of their interpole motors. F. G. Bell, F. S. Mitchell and Geo. B. Warren represented the company.

THE DALE COMPANY, New York, occupied a very large space, filled with samples of the Dale line of fixtures. John Dale, O. J. Bryan and H. S. Rainford were present during the week.

NATIONAL CARBON COMPANY, Cleveland, O., had a display showing samples of everything

THE BENJAMIN ELECTRIC MFG. COMPANY, New York and Chicago, had show boards displaying the Benjamin wireless clusters, arc burst, daylight clusters and car clusters. Basil G. Kodjbanoff was in charge of the exhibit.

PASS & SEYMOUR, Syracuse, N. Y., were represented by J. W. Brooks, A. M. Little and W. B. Hall. A full line of P. & S. specialties was on exhibition, as well as the new brass shell sockets and receptacles made by the firm.

SPRAGUE ELECTRIC COMPANY, New York, was ably represented at the convention by Alec Henderson, master of transportation of the N. E. C. A., who arrived Tuesday evening in charge of a large party of delegates from New York.

G. M. GEST, New York and Cincinnati, was represented at the convention by W. T. Jackson, Western representative, who showed a large variety of photographs of the different kinds of conduit work done by Mr. Gest all over the world.

THE OSBURN FLEXIBLE CONDUIT COMPANY, New York, had an attractive display of

flexiduct in connection with the exhi'it of the Pettingell & Andrews Co., their New England agents. Mr. C. E. Corrigan represented his company.

J. L. GLEASON, Jamaica Plain, Mass., had a very handsome exhibit of his line of moulding boxes. He recently brought out a number of new specialties, samples of which were shown and explained. J. L. Gleason and R. Eberhardt were in attendance.

THE CHASE-SHAWMUT COMPANY, Newburyport, Mass., displayed samples of the standard fuses, Shawmut conduit outlet bushings, Shawmut rapid conduit and moulding hangers. Harry P. Moore, J. F. S. Nichols, Jr., J. J. Miley and Frank D. Masterson were in attendance.

CHARLES A. COTTON, Boston, New England agent for the Triumph Electric Company, Century Electric Manufacturing Company and the Warren Electric Company, had a large exhibit of the motors built by these companies. Charles A. Cotton and A. J. Ruel were in charge of the exhibit.

S. H. COUCH & CO., Boston, Mass., had an exhibit of their line of telephones, shown on revolving pedestals. One of their newest was the Couch automatic vestibule 'phone for apartment houses. Wm. Couch and C. E. Monroe explained the merits of their line and distributed souvenir match safes.

THE HOLOPHANE COMPANY, New York, had some very interesting samples of the Holophane products. The newest shade shown was the new Pagoda ball, wide-angle reflector, together with some handsome cut-glass effects. The exhibit was in charge of I. W. Farquharson and H. C. Jones, Boston representative.

JOHN A. ROEBLING'S SONS COMPANY, Trenton, N. J., occupied a very handsome booth, which was considered by some the coolest spot in the show. Mr. H. L. Shippey, treasurer and manager of the New York office; Albert Mann, New England agent; Frank W. Harrington and S. B. Van Norturck were in attendance.

EXHIBITS OF THE AMERICAN CIRCULAR LOOM COMPANY AND PERKINS ELECTRIC SWITCH MANUFACTURING COMPANY.

H. W. JOHNS-MANVILLE COMPANY, New York, had an attractive display of Sacks noark fuses, standard fuses; in fact, fuses, fuse boxes and fuse blocks for every possible service. J. W. Perry, manager of the electrical department, New York; A. D. Newton, manager electrical department, Boston; E. L. Cameron and W. R. Walsh were in attendance.

THE O. C. WHITE COMPANY, Worcester, Mass., had a handsome exhibit of shop wall fixtures, etc. The company showed fixtures designed for every practical requirement of applied illumination. Two specialties which it has brought out this season were a portable lamp fixture and a new strap clamp desk fixture. O. C. White, Jr., was in charge of the exhibit.

MARSHALL ELECTRIC MFG. COMPANY, Boston, Mass., had a very attractive booth decorated in red and white. Samples were shown of the company's complete line of sockets, cutouts and switches. Norman Marshall was attending the convention. E. G. Eastman had charge of the exhibit. A combination key ring and screwdriver was given out as souvenirs.

PASS & SEYMOUR AND GENERAL ELECTRIC COMPANY EXHIBITS.

R. M. CORNWELL COMPANY, Syracuse, N. Y.—The booth occupied by this company was most attractively decorated. The company had on exhibition samples of the Cornwell universal switch boxes, wonder dynamos and motors for experimental purposes, and the wonder gasoline engine in several sizes. Mr. R. M. Cornwell and F. S. Baldwin had charge of the exhibit.

C. S. KNOWLES COMPANY, Boston, Mass., had a display of their enamel duct conduit, high-tension porcelain glass insulators and B. & D. specialties. They also had on exhibition a 300,000-volt transformer for testing insulators. The following gentlemen were in attendance: George A. Ober, Duncan Kennedy, A. D. Richmond, H. M. Saben, A. J. Sanford, Jr., and W. O. Turner.

BOSSERT ELECTRIC COMPANY, Utica, N. Y.—The space occupied by this company was most attractively furnished and samples of outlet boxes, outlet bushings, knife switches, and a line of novel and up-to-date panel boards were displayed. F. B. Smith, New England sales agent, and F. T. Foxenberger were busy explaining the merits of the Bossert line to visiting delegates.

THE AMERICAN ELECTRIC NOVELTY & MANUFACTURING COMPANY, New York.—This exhibit was in charge of Mr. F. J. Alvin, general manager. Wm. G. Mills and S. S. Shephard were also in attendance. Theirs was a very elaborate booth, filled with samples of the famous ever-ready battery, minature and decorative lamps, Noscru push buttons, keyless clocks, portable lamps, etc.

W. S. HILL ELECTRIC COMPANY, New Bedford, Mass., had on exhibition sample boards of its line of switches together with a board showing I. T. E. circuit breakers manufactured by the Cutter Electrical Manufacturing Company, for whom the Hill Company is New England agents. W. C. Jessup, sales engineer, and F. A. Knowles, manager of the Boston office, represented the company.

SAFETY-AMORITE CONDUIT COMPANY and the CONDIT ELECTRICAL MANUFACTURING COMPANY had a very attractive booth. S. B. Condit, Jr., R. G. Garland and F. Hodkinson represented the Safety Company, while Mr. S. B. Condit, Jr., P. Fisher and F. W. Mason looked after the interests of the Condit Electrical Manufacturing Company. Very handsome and useful desk clocks were distributed as souvenirs.

PETTINGELL-ANDREWS COMPANY, Boston, occupied one of the largest booths in the building, and had on exhibition samples of practically everything in the electrical supply line. The following gentlemen were in attendance, representing the company: C. B. Price, general manager and treasurer; F. S. Price, secretary; W. J. Keenan, sales manager. Wm. A. Peterson, R. W. Vose, H. H. Van Staagen and F. W. Cramphorn.

THE TRUMBULL ELECTRIC MANUFACTURING COMPANY, Plainville, Conn., had what was perhaps the most attractive show board in the entire exhibition. It was a quartered oak cabinet finish board, 15 feet long by 7 feet high, upon which were displayed samples of the entire line

of switches, cut-outs, panel boards, etc., manufactured by this company. Mr. J. H. Trumbull, president; F. Trumbull and Geo. W. Edge were in constant attendance.

EASTERN CARBON COMPANY, Jersey City, N. J., had its booth tastefully decorated with red and yellow bunting; the prevailing colors in the label of their dry cell. Samples of gas ignition cells, telephone cells, new battery connectors, carbon specialties, eastern flash lights in all sizes and shapes, and a new combination carbon brush composed of wire gauge and carbon were on exhibition. The following gentlemen were in attendance: George W. Mills, William Mills, O. L. Turgeon.

EXHIBITS OF THE MARSHALL ELECTRIC MANUFACTURING COMPANY AND R. M. CORNWELL COMPANY.

THE AMERICAN CIRCULAR LOOM COMPANY, Chelsea, Mass., following its usual liberal policy, had one of the largest exhibits in the building. Across each end of the space were two large circular loom trucks loaded with circular loom. The centre of the space was filled with weathered oak furniture, palms, flowers, etc., very artistically arranged. The following gentlemen were in attendance: A. J. Clark, H. P. Kirkland, Oscar Hoppe, R. B. Corey, T. H. Bibber, H. C. Adams, Jr., and M. W. King.

THE ELECTRIC GAS LIGHTING COMPANY, Boston, had a remarkably fine showing of interior telephones and switches. The company was represented by H. C. Thomson, general manager; W. F. Abely, Mr. Boardman, Mr. Youny, Mr. Sherman, Mr. Howes, Mr. Norris, Mr. Lee, besides Mr. Haines, manager of the Chicago branch, and Mr. Bongard from the Toronto branch. Much favorable comment was made on its new metallic circuit, automatic intercommunicating telephone. The company claims this is the most important departure in the history of interior telephone manufacture, inasmuch as it gives a complete and separate metallic circuit to every talking pair; not only does the operator at will select the metallic circuit of the desired correspondent, but when a conversation is in progress interruption by outsiders is entirely impossible. The "Rotokoll" switchboard was also shown.

BRYANT ELECTRIC COMPANY, and PERKINS ELECTRIC SWITCH MFG. COMPANY. —This is the first time these companies have ever made an exhibit of their line. Much credit is due to Mr. E. R. Grier, sales manager, for the very effective display made. This company manufacture over 2,000 different articles and are the largest manufacturers of what they term "electrical hardware" in the world. Their main exhibit was a tent shape arrangement of show boards. On one side was shown the Perkins Electric Switch Mfg. Company's lines of switches, from 15 amperes to 400 amperes. They build more than 400 sizes between. On the other side of the board the Bryant Electrical Company's sockets and receptacles were shown. At one end there was a very artistic display of cartridge fuses and fuse blocks. This is an entirely new line for the Bryant Electric Company. On separate boards were shown different finishes for sockets and switches. The following gentlemen were present: W. C. Bryant, manager and treasurer; E. R. Grier, sales manager; E. K. Patton, Western manager; G. W. Goodrich, general superintendent; B. C. Gilpin and Frank B. Burton.

THE WESTINGHOUSE EXHIBIT.

THE GENERAL ELECTRIC COMPANY had one of the largest spaces in the center of the main floor, covering about 1,300 square feet. The principal feature of this exhibit, and probably the newest thing in the entire Exhibition, was the new G. E. 2½ watt incandescent lamp. The company's exhibit was brilliantly illuminated with these units. This is the first exhibition to the general public where this carbon filament has been shown. The new metallized carbon filament lamp is made in three sizes, Nos. 3, 4 and 5, the watt consumption being 125, 187½ and 250 watts per lamp, respectively. These lamps are used with a special line of Holophane Pagoda reflectors which are made in two forms, one known as the "Form D," which distributes the light in a downward direction, and the other known as the "Form C," which concentrates the candle-power in a downward direction. The company also exhibited a mercury arc rectifier operated on 220 volt, single-phase, which was converted to 110 volts, direct current, the load being a circuit of the new incandescent lamps. This rectifier had a capacity of 30 amperes and was in constant operation. A collection of small motors of various types was shown. This included alternating and direct-current motors. One of the company's new automobile motors was also exhibited, as well as a miscellaneous collection of the company's standard electric motor fans. A new G. E. electric flat-iron also made its appearance here for the first time and naturally attracted a great deal of attention from the public. The company's moving picture machines were constantly surrounded during the exhibition. In attendance at the exhibit were Mr. C. B. Davis, Boston manager; Mr. J. P. Felton, supply manager Boston office; Mr. O. F. Brastow, L. E. Smith and J. A. Wilson, Boston; Mr. E. M. Kinney, Schenectady, N. Y.; Mr. W M. Wright, New York, and Mr. F. H. Gale, advertising manager. Other callers during the week were Mr. T. Beran, New York supply manager, and Mr. D. R. Bullen, Schenectady.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY occupied an entire platform at the west end of the main hall. Over the center of the exhibit was a large, high-potential electric sign bearing the word "Westinghouse" in porcelain letters on a dark background. The letters were backed with tin foil and alternating discharges at 30,000 volts between the backs produced striking effects. Various types of Sawyer-Man lamps were displayed in a glass case on the platform. Along the front of the platform were vertical standards bearing a nice display of Nernst lamps. A 42-in. Stafford fine yarn cotton loom was shown in full operation, being gear driven by a ½ h.p. three-phase, 200-volt, 25-cycle induction motor with automatic stopping devices actuated by the breaking of the thread in the weaving process or other mishaps in the loom proper. The purpose of showing this outfit was to demonstrate the feasability of driving such a loom without intermediate clutch or other starting device. The cotton was woven by an expert weaver and portions of it distributed as souvenirs. Souvenir postal cards illustrating historic points of Boston were also distributed. A line of central-station and portable testing instruments was on exhiibtion, as well as Cooper Hewitt mercury vapor lamps, fuses, arc lamps, etc. A biograph exhibition comprising a trip to the Westinghouse shops at East Pittsburg was given nightly. The company was represented by the following attaches of the main and district offices of the company: R. L. Warner, New England manager; C. B. Humphrey, manager detail sales; G. B. Griffin, assistant manager detail sales; D. E. Manson, manager Boston office; H. B. Whipple, general lamp agent; J. William Smith, cashier Sawyer-Man Company; Messrs. Watts, Merrill, Bates, Osborn, Gibbs, Bond, Chase, Wahn, Abbott, Walton and Ewing of the Boston office of the Westinghouse Electric & Manufacturing Company; D. E. Clark, manager The Westinghouse Machine Company; Mr. Holbrook, manager Boston office Nernst Lamp Company, and J. C. McQuistion, superintendent of the Westinghouse Companies Publishing Department, who had charge of the Westinghouse exhibit.

CENTRAL STATION NEWS

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

ALABAMA.

DOTHAN.—It is reported that it is proposed to improve the water works and electric light plant, at a cost of $20,000.

ENSLEY.—The Street and Light Committee of Council is reported to have agreed to recommend to the Mayor and Board of Aldermen the construction of an electric light plant.

MONTGOMERY.—The Montgomery Light & Water Power Company has just placed an order for additional machinery for its large plant at Tallassee, which will involve an expenditure of nearly $30,000.

JACKSON.—The lighting plant at this place, which was only completed December 15, 1904, already requires extension. It is proposed to add an overshot water-wheel. Geo. P. Brockman is electrical engineer and superintendent.

TROY.—Messrs. Chas. Henderson, H. D. Boyd and others, together with the owners of the Elba Electric Power Company, have organized the Pea River Power Company, paid up capital $50,000, authorized $200,000. They are arranging for the erection of a power house, etc. Their plans include an electric plant and railway service from Troy to Elba and perhaps on the Gulf.

ALASKA.

FAIRBANK.—The Tanana Electric Co. is reported to have been incorporated at Olympia, Wash., by Abe Spring, of Fairbank, and J. A. Haney, of Seattle, Wash., with a capital of $250,000, to establish a lighting and steam plant at Cleary City, Alaska, which is about 25 miles from Fairbank.

ARKANSAS.

IMBODEN.—A $25,000 electric lighting plant and water works is being put in at this city.

LITTLE ROCK.—The Columbia Light & Power Company filed a notice of dissolution of that corporation and surrendered its charter.

TEXARKANA.—The Texarkana Gas & Electric Light Co. has changed its name to the Texarkana Gas & Electric Co. and reduced its capital stock from $200,000 to $100,000.

CALIFORNIA.

SAN FRANCISCO.—The Sierra Nevada Water & Power Company has been incorporated, with a capital of $5,000,000, by G. B. Crittenden, W. L. Stowell, R. M. Kreiser, and others.

LOS ANGELES.—The City Council has been asked by the Municipal League to consider the matter of a municipal lighting plant. The present cost of lighting is about $133,000 annually.

VENTURA.—The proposed electric light plant for Ventura will cost $25,000, and the water works $100,000. It is uncertain when the contracts will be let, as the matter is delayed by ligitation.

LOYALTON.—The Loyalton Electric Light Company is extending its service to Beckwith, 17 miles from here, across the Sierra Valley. The town of Beckwith will be lighted by electricity in the near future.

SAN FRANCISCO.—The Board of Supervisors has passed a resolution awarding to the San Francisco Gas & Electric Company the contract for supplying the city with gas, electric light and power during the year, for $320,000.

OAKLAND.—The bid of the Oakland Gas, Light and Heat Company for lighting the city for the next fiscal year, has been accepted and the contract awarded it on a schedule that will furnish light all night every night in the year.

LOS ANGELES.—A new city ordinance has gone into effect, providing that electric energy supplied by the lighting company shall not vary more than 3 per cent. from the standard; also for tests of electric meters to be made by the city electrician.

LOS ANGELES.—The City Council has passed a new ordinance under which corporations will be obliged to submit a complete financial statement annually to the city after Jan. 1, 1906. The Council is empowered to fix a price for the service provided.

SAN FRANCISCO.—It is understood that the Merchants' Mutual Light & Power Company, of Santa Barbara, has placed provisional orders for a McEwen engine with Henshaw, Bulkley & Co., and for 250-kw., 3-phase belted generators with the Bullock Electric Company.

LOS ANGELES.—Various interested companies have been holding meetings for the purpose of devising plans whereby telegraph, telephone, electric lighting and trolley poles shall be removed throughout the city and consolidated systems erected in their place down alleys and back streets.

SAN FRANCISCO.—The Shasta Power Company will have a stockholders' meeting, Aug. 26th, to act upon a proposition to create a bonded indebtedness of $100,000 for the purpose of raising money to complete the construction and equipment of its hydro-electric transmission plant on Bear Creek, Shasta County. Work is now in progress.

ANAHEIM.—The City Trustees of Anaheim are considering the advisability of leasing the city electric light plant to the Edison Electric Company. This company claims that it can operate the plant cheaper than the city. It offers to pay the city 12 per cent. of the gross receipts of the lighting service, with an agreement to give the city the right to terminate the contract, in a year.

SAN FRANCISCO.—The Reno Power, Light & Water Co.'s plant at Reno, Nev., was shut down for ten days while the armature of the main generator was being rewound. The company's circuits were temporarily supplied from the Truckee River General Electric Company's plant at Floriston. The burn-out was caused by a cat, which climbed a pole on the high-tension line in Reno and produced a short circuit.

LOS ANGELES.—Broadway, in this city, which is over a mile long, is one of the best lighted thoroughfares in the world. Electroliers stand on either side of the street, having been created at an expense of about $15,000 by abutting property owners. These poles display 1600 ornamental incandescent lights, effectively softened by milk-white globes. This system, recently installed, is lighted by the municipality at a cost approximating $900.

CONNECTICUT.

FARMINGTON.—The Farmington River Power Company has elected directors as follows: Austin C. Dunham, James L. Howard, Atwood Collins, Henry Roberts, E. C. Terry, John S. Hunter, W. T. Bacon and H. C. Judd.

SOUTH NORWALK.—The Board of Electrical Commissioners has awarded contracts for an enlargement of the city electrical station. The proposal of the Diesel Engine Company for an engine was accepted. The contract for electrical equipment was awarded to the Fort Wayne Electric Works.

YALESVILLE.—At a borough meeting in Wallingford, $4,500 was appropriated to buy the Hotchkiss Bros.' property and rights. This purchase takes in one of the finest water privileges in the county, and will grant to the electric plant at Wallingford all the power necessary to extend it to Yalesville.

FLORIDA.

JACKSONVILLE.—Bids will be received until Aug. 4 by the Board of Trustees of the Water Works and Improvement Bonds, for furnishing f. o. b. cars Jacksonville, a motor generator set of about 300-kw. capacity, the generator to be a 550-volt, direct-current, compound-wound machine, driven by a direct-connected, three-phase, 60-cycle, 2,300-volt, synchronous motor, large enough to drive the direct-current generator to its rated capacity, machine to be arranged so as to be reversed; and an alternate bid for the same generator driven by a three-phase, 60-cycle, 2,300-volt induction motor, direct connected, of sufficient size to drive the generator to its rated capacity, the speed of the machine not to exceed 750 revolutions per minute, the machine to be mounted on a substantial cast iron base and to have large self-oiling bearings. Field rheostat for the generator and starting device for the alternator to be furnished, a full specification, giving dimensions, together with blue print or photograph to accompany the bid, and state time in which delivery can be made. R. N. Ellis, Supt.

GEORGIA.

CALHOUN.—Geo. C. Chambers, of Calhoun, will construct an electric light plant to cost from $3,500 to $4,000, and operate it with water power.

FT. GAINES.—The City Council is reported to have granted the Interstate Water Works & Construction Co., of Washington, D. C., a 50-year franchise for the construction of water works and an electric light plant.

COVINGTON.—The town of Covington has awarded a contract to W. R. Jennison, of Atlanta, for installing the new machinery for the electric lighting plant which is to be rebuilt, having been demolished by a boiler explosion.

IDAHO.

HAILEY.—The Abner Doble Company has recently secured the contract for the machinery to be installed in an addition to the hydro-electric plant of the Cramer Electric Company, successor to the Idaho Electric Supply Company, at Hailey, Idaho. This contract covers the entire water power and electrical apparatus and includes a 400-kw. alternator directly driven by an 800-h.p. set of water-wheels, exciter and governor; three-panel marble switchboard, two 25-light arc transformers and 50 arc lamps with regulators, switchboards and other accessories; 14 transformers and other supplies for the distribution system.

ILLINOIS.

OTTAWA.—The Ottawa Power Company has been formed with a capital of $5,000. James A. Seddon, Robert Gaylord and others are the incorporators.

BLOOMINGTON.—The Consumers' Light & Heat Company has been incorporated with a capital stock of $100,000. The incorporators are George M. Mattis, S. A. Power and Charles Zilly.

CHICAGO.—Plans have been filed by the Commonwealth Electric Co. for a 2-story power house to be constructed at 22d and Fisk Sts., to cost $50,000; also for a 1 and 2-story brick power house, to cost $35,000.

GRANITE CITY.—This city is in need of a good up-to-date electrical plant for street and commercial lighting. The place has a population of about 8,000, and is growing rapidly. Mr. Alvin Morefield can give information to any one interested.

QUINCY.—The Quincy Gas & Electric Company has changed its name to Quincy Gas, Electric & Heating Company. The number of directors has been increased from five to seven, and the capital stock increased from $600,000 to $2,000,000.

CHICAGO.—The Chicago & Suburban Water & Light Co. has accepted the offer suggested by Mayor Dunne that the city purchase its plant in Austin for $250,000, and an ordinance for the purchase of the system at this price has been introduced in the council.

LA GRANGE.—The LaGrange Service Company is building a large power house at Maywood. The La Grange light and water plant will also be improved, and Sargent & Lundy, of Chi-

cago, will prepare plans for a model power house. The pumps will be operated by electric power. An extra 150 horse-power boiler and engine will be installed to be used in case of accident to the Maywood plant.

INDIANA.

POSEYVILLE.—The Poseyville Electric Light & Water Company is reported incorporated, with a capital of $10,000.

EVANSVILLE.—The Evansville Gas & Electric Light Company, Evansville, Ind., is planning to erect a plant to supply power to various traction lines.

TELL CITY.—It is reported that bids will be received by Frank Hinkle, City Clerk, for new machinery to be installed at the electric light plant.

LOGANSPORT.—The City Council has passed an ordinance governing the stringing of wires in the city, providing for inspection and the licensing of all electrical workers.

KOKOMO.—The Kokomo Gas & Light Company has incorporated with a capital stock of $100,000. Alexander Linderman, K. L. Ames, L. S. Owsley and B. S. Wales are directors.

PERU.—Wm. O'Hara, City Clerk, writes this city has in contemplation the reconstruction of its electric light plant, and would like to have some one complete the project, both financially and mechanically.

CRAWFORDSVILLE. — The Crawfordsville Water & Light Company is stated to have secured a new franchise, and will at once make extensive improvements and purchase new machinery.

WATERLOO.—The Waterloo Electric Light Company has experienced considerable annoyance from the burning out of transformers by lightning. The repairs have to be made in Fort Wayne, often causing considerable delay. The company will solicit bids for putting up lightning arresters.

IOWA.

NEW SHARON.—The New Sharon Electric Company has just been incorporated.

ACKLEY.—The Ackley electric light and heating plant has been sold by Smith Bros. to John Rath.

SPIRIT LAKE.—This city has decided to expend about $6,000 in improving the electric light plant.

WASHINGTON.—The Iowa Gas & Electric Company is reported incorporated with a capital of $100,000.

NEWTON.—The Council will purchase a storage battery equipment for the electric light plant, at a cost of $8,000.

FORT DODGE.—The City Council has appointed a committee to investigate the construction of a gas and electric light plant, to be owned and operated by the city.

DAYTON.—The Dayton Heating & Lighting Company has been organized with C. D. Waterbury, president, and H. E. Nelson, secretary, and a capital of $10,000.

KANSAS.

BURLINGTON.—The electric light plant of this city has been purchased by G. H. Webb and G. Webb.

PITTSBURG.—The Pittsburg Railway & Light Company, of this city, has been organized with a capital of $600,000.

COTTONWOOD FALLS.—The Smith Light & Power Company, of Bolivar, Mo., has received a franchise from this town and is installing a plant here.

CHETOPA.—Burns & McDonnell, Kansas City, Mo., are preparing plans and specifications for water works and an electric light plant, to cost about $30,000.

ALMA.—The Mayor and Councilmen granted an electric franchise to the Alma Light & Power Company, which is composed of W. B. Wilson, G. A. Mueller and others.

KENTUCKY.

RUSSELL.—E. F. Fullerton and H. Willis, of Greenup, are reported interested in the construction of an electric light plant in Russell.

CAMPBELLSVILLE.—Articles of incorporation have been filed with the County Clerk at Campbellsville, Ky., to build and operate an electric light plant there, to be known as the Campbellsville Electric Light Company. The officers are: J. L. Adkinson, president; C. R. Davis, secretary and treasurer; B. S. Kincart, manager.

MAINE.

NORTH FAIRFIELD.—The Crosby Mercantile Company is to install an electric light plant which will provide light and power for its large interests here.

HOULTON.—There is a proposition to make a contract with the Maine & New Brunswick Electrical Company to furnish electricity for lighting, heating and power purposes to the town.

MARYLAND.

ELKTON.—The County Commissioners are stated to have granted permission to Wm. T. Harburton, president Elkton Electrical Light Co., to erect a pole line from Gilpin Falls, at Bay View, to Elkton, via Pleasant Hill.

BALTIMORE.—At the annual meeting of the stockholders of the Mount Washington Electric Light & Power Company, the following officials were elected for the ensuing year: President and general manager, Thomas W. Offut; vice-president, Alten S. Miller; secretary and treasurer, Harry J. McIntyre; directors, Thomas W. Offut, Alten S. Miller, S. Davies Warfield, Walter R. Townsend and Richard A. Bevan. The company is expending about $100,000 for the power house and new machinery, and will have the new plant in operation by Sept. 1.

MASSACHUSETTS.

CLINTON.—The Clinton Gas & Electric Company has decided to borrow $250,000, a part of which will be expended for improvements.

TEMPLETON.—A corporation will soon be formed under the laws of Massachusetts to furnish electric light and power in the town of Templeton.

LEOMINSTER.—The Leominster Electric Light & Power Company has secured the contract for lighting the city for the coming year at the following bids: 92 arc lights at $72 per year, each to burn until 1 a. m.; 20 arc lights to burn all night, at $110 per year, and 72 incandescents at $10 each; total cost, $9,976 per year.

MICHIGAN.

PLAINVILLE.—The Esele Light & Power Company has bought the franchise and the plant of the Brownell Lighting Company.

WEST BRANCH.—W. D. Eddy has been granted a 10-year franchise to operate an electric lighting plant at West Branch. He has bought the interests of W. W. Vaughn and will at once make improvements in the plant.

TAWAS CITY.—The Tawas Manufacturing Company will operate an electric light plant within a month. The plant is being installed by the city and the company will get its revenue out of commercial lighting.

HOUGHTON.—The Houghton County Electric Light Company will install an electrically driven, vertical, triplex pump at the Franklin pumping station, capable of supplying 65,000 gallons of water every 24 hours.

PORTLAND.—The municipal lighting plant will be increased in capacity by widening and deepening the race which conveys the water for power. W. D. Fargo, of Kalamazoo, will have charge of the work, which will be completed at a cost of $3,760. The plant will be shut down for at least four weeks.

LANSING.—The annual report of the municipal lighting plant shows a material gain. The cost of operating the plant in 1905 was $34,037.02, in 1904 it was $32,991.40. The increase in receipts from private consumers was $6,941.69, the total for 1905 being $41,858.12. The total earned receipts exceeded the operating expenses by $22,821.10.

ANN ARBOR.—The stock of the Washtenaw Light & Power Company is reported to have been purchased by Alex. Dow, of Detroit; R. W. Hemphill, Jr., of Ypsilanti, and others. The directors are reported to have decided to develop the Huron River power, manufacture gas and extend the power service in Ann Arbor and Ypsilanti.

MINNESOTA.

AUSTIN.—It is reported that the Electric Light, Power and Water Commission will expend about $20,000 for improvements at the electric light plant.

WARREN.—J. G. Robertson, of St. Paul, has secured the contract for a 125-h.p. boiler and engine for the electric light plant, and the Fort Wayne Electric Works, Fort Wayne, Ind., for a 75-kw. dynamo; total cost, $6,225.

INTERNATIONAL FALLS.—The International Light & Water Company has been incorporated with a capital stock of $50,000. The incorporators are E. W. Backus, W. F. Brooks, R. L. Horr and C. J. Rockwood, Minneapolis; H. V. Winchell, Butte, Mont.

MELROSE.—Contracts for constructing an electric light plant and water works have been awarded as follows: To the Dwyer Plumbing & Heating Company, of St. Paul, for plant complete, except electric portion, and to the American Electric Company, of St. Paul, for the electrical portion. Engineer, Oscar Claussen, St. Paul.

MISSOURI.

WEBB CITY.—J. C. Harrison and Robt. Holt, of Carthage, have petitioned for a franchise and contract to light Webb City.

CAMDEN.—The Camden Water, Light & Power Company, of Missouri, has filed a certificate designating Daniel Davies, of Camden, as agent for Arkansas, and that $30,000 of its $50,000 capital is in use in Arkansas.

KIRKSVILLE.—The Missouri Heat, Light & Power Company, of Kirksville, has been incorporated with a capital of $50,000, three-fifths paid. The incorporators are O. H. Davidson, of Des Moines, Ia.; W. B. Kinnish, of Adel, Ia.; J. H. Shively, of Perry, Ia.; C. H. Shively, W. T. Baird and M. D. Campbell.

ST. LOUIS.—The West Cabanne Improvement Company has filed an application for articles of incorporation for the purpose of furnishing light, heat and power in the city of St. Louis and St. Louis County. The capital is to be $25,000, half of which is paid. Thomas C. Henning owns a majority of the stock. Among the other stockholders are W. W. Colver, Arthur E. Ewing, Montague Punch, William Yule, Jesse P. Baker, George Kingsland, W. F. Funston and Charles E. Ware.

MONTANA.

LIVINGSTON.—An electric power plant, to cost about $60,000, will be established here shortly by Lewiston capitalists. John L. Bright is at the head of the project.

MISSOULA.—The Missoula Light & Water Company has ordered from the Westinghouse Machine Company a 500-kw., three-phase, 60-cycle, 2,200-volt Westinghouse-Parsons steam turbine. Other contracts for motor-driven exciter sets, switchboard material and surface condensing outfit have also been placed, the whole aggregating about $30,000.

HELENA.—The Helena Power Transmission Company, a subsidiary company of the Missouri River Power Company, is about to undertake the construction of a new dam and power plant on the Missouri River, about 15 miles below its present plant. The plant will have a head of about 60 feet and a capacity of about 20,000 horse-power, which will be transmitted to Helena, Butte and Anaconda. The Missouri River Power Company's transmission lines will be extended from Butte to Anaconda, making a total distance of transmission from the new plant to Anaconda of about 100 miles. The transmission will be operated at 70,000 volts. Mr. M. H. Gerry, Jr., is, as is well known, general manager of the Helena company.

NEBRASKA.

TECUMSEH.—An election will probably soon be held to vote on issuing $9,500 bonds for a new electric light plant. P. H. Hopkins, Mayor.

OMAHA.—An ordinance is before the Council providing for laying of electric wires underground within the district bounded by P street, 23d street on east, Q street on south, and 26th street on west.

NEVADA.

BISHOP.—Mr. W. Wayne Belvin, president of the British-American Finance Company, who returned to New York from a business trip to the new gold fields of Nevada, announced the organization of the Bishop-Nevada Electric Power & Lighting Company, with a capital of $1,000,000. Associated with him in the enterprise is James Butler, the original discoverer of the Mizpah mine at Tonopah; Clay Peters, a capitalist of California; Warner Miller, of New York, and a number of San Francisco capitalists. It is the purpose of the company to build an immense electric plant on the Owens River, near the town of Bishop in Nye County, across the line from Nevada in California and generate the electricity by means of water power to Tonopah, Goldfield and Bullfrog; and also to build and operate electric railways in the State of Nevada. The bonds of the company have been underwritten and the work of construction will begin at once.

NEW HAMPSHIRE.

PORTSMOUTH.—The Rockingham Light & Power Company is putting in a large new fan to be used for induced draft in the boilers and chimney at the power plant at Portsmouth, N. H. The company has also contracted with the Hodge Boiler Works, of East Boston, for the erection of a large tank to hold 135,000 gallons of feed water for the boilers. This will be taken directly from Beverly Springs.

NEW JERSEY.

SOUTH ORANGE.—The Village Board of Trustees has appointed a committee, with President Sinclair as chairman, to inquire into the municipal ownership of an electric light plant.

JERSEY CITY.—The Southern Power Company has been incorporated with a capital stock of $7,500,000. The incorporators are R. B. Harrington, E. B. Sperry and W. R. Journeay, Jr.

NEWARK.—The Board of Works has approved the resolution directing Morris R. Sherrerd, Chief Engineer and City Surveyor, to ascertain the cost of equipping either the Belleville or the Clifton Avenue pumping station as an experimental municipal lighting plant.

TRENTON.—The Northumberland County Ry. & Light Company has been incorporated at Trenton, N. J., with a capital of $1,000,000, to supply gas and electric light for cities and to construct outside of New Jersey railroads for the transportation of passengers and freight. Incorporators: Wilbur F. Sadler, Jr., Trenton, N. J., and Wm. W. Hepburn and Geo. Parkman, both of Philadelphia, Pa.

NEW YORK.

SPRING VALLEY.—The question of constructing an electric light plant at a cost of $25,000 is reported under consideration.

LITTLE FALLS.—Jas. G. Hazlett, City Clerk, writes that the Hudson River Power Company has petitioned for a franchise for lighting and power purposes.

NIAGARA FALLS.—The Niagara Falls Hydraulic Power & Manufacturing Company is reported to have decided to erect a new power house and improve the canal.

LOCKPORT.—The American District Steam Company is reported to have petitioned Council for a franchise to use the city streets and supply light, heat and power in Lockport.

ANDOVER.—The Andover Electric Power & Light Company, of Andover, has been incorporated with a capital of $10,000, by R. A. Stout, A. B. Richardson and J. H. Backus, all of Andover.

PARISH.—The Parish Lighting Company is reported incorporated, with a capital of $2,000, to manufacture gas for lighting. Incorporators: R. C. Robertson and Geo. Weaver, of Parish.

PAUL SMITH'S.—The Paul Smith's Electric Light & Power Company has been incorporated with a capital stock of $100,000. The directors are Paul Smith, Phelps Smith and Paul Smith, Jr.

CAIRO.—The Cairo Electric Light & Power Company has been incorporated with a capital stock of $80,000. The directors are C. E. Hewitt, M. G. Hubbard, Chatham, N. J.; F. G. Walters, Cairo.

TROY.—The Board of Contract and Supply is reported to be considering the question of establishing a municipal electric light plant to be used for lighting Monument Square and city buildings in that locality.

NEWBURG.—It is reported that the Cornwall Electric Light & Power Company will sell out to the Newburg Electric Light, Heat & Power Company. Capt. Thomas Taft is at the head of the Cornwall company.

OGDENSBURG.—It is reported that electric power, generated at Hannawa Falls, 30 miles from Ogdensburg, by the Hannawa Falls Water Power Co., is to be transmitted to this city for use of the Ogdensburg Power & Light Co.

LOCKPORT.—The Niagara, Lockport & Ontario Power Company has filed with the Clerks of the counties of Erie, Monroe, Orleans, Seneca, Wayne, Ontario, Cayuga and Onondaga certificates of extension of business in these counties.

TONAWANDA.—The Council is reported to have granted franchises to the Niagara Falls Electrical Transmission Company and the Niagara, Lockport & Ontario Power Company. Both companies must maintain their stations within Tonawanda.

NORTH CAROLINA.

SANFORD.—The town of Sanford is considering purchasing the electric light plant of the late A. F. Spooner. The plant is valued at $19,000, but can be purchased at about $6,500.

ASHEVILLE.—A meeting of the water and light commission will be held to consider the issuing of water bonds, and also $40,000 electric light bonds for constructing a plant on Swannanoa River.

GREENSBORO.—J. M. Bandy and W. H. Terrell, of Greensboro, are the engineers in charge of the development of water power on South Yadkin River for the Southern Yadkin Development Company. The work contemplated will cost about $1,000,000.

ALBEMARLE.—The Albemarle Light & Water Company has been incorporated with a capital of $25,000 by A. L. Patterson, J. M. Morrow and others, all of Albemarle. R. Smith, secretary, writes that the company is in the market for an outfit for a small electric light plant.

CHARLOTTE.—It is reported that the Catawba Power Company, of Charlotte, is seeking additional water power for electric development on account of their rapidly growing business and the increasing demand for power, which has about taken up all the available power in sight.

CHARLOTTE.—The Southern Power Company has been organized in New York City with a capital stock of $7,500,000, to develop large water powers on the Catawba River in North Carolina and upper South Carolina. The new company is organized under the laws of New Jersey, and Dr. W. Gil Wylie, of New York, is president; B. N. Duke, of Durham, N. C., first vice-president; W. S. Lee, of Charlotte, second vice-president and chief engineer. The offices of the company will be in Charlotte, N. C. The first power to be developed will be at the Great Falls of the Catawba, where a plant will be erected costing about $1,500,000.

OHIO.

GALION.—The Crawford Gas & Electric Company, recently organized here, is reported to be preparing to construct a power house here, at a cost of $75,000.

YOUNGSTOWN.—The Electric Supply & Construction Company, of Youngstown, has secured the contract for installing an electric light system at the new filter plant for $4,133.

BELLEFONTAINE.—C. W. Buchanan, Superintendent City Electric Light Plant, writes that bids will be received by the Board of Public Service, Aug. 10, for constructing a new electric light plant; probable cost, $50,000.

CANTON.—The Citizens' Light, Heat & Power Company has sold out to the Merchants' Heat, Light & Power Company. The new company is composed of Canton business men who have selected Thomas F. Turner as their president.

BELLEVUE.—The Mutual Light & Water Company has secured a franchise to light the streets by electricity. The company is about to be incorporated, with a capital of $50,000. The incorporators are E. C. Crocker, B. F. Bell, Peter Brady, and others.

NEWARK.—The Citizens' Electric Light & Power Company's plant and business, of Newark, has been sold to Congressman B. G. Dawes, Col. M. M. Gillette, and several other local capitalists, who have formed a corporation for the purpose of conducting the business.

COLUMBUS.—Recently the Council passed an ordinance fixing the rate for lighting purposes at 5 cent per kilowatt hour. The Columbus Railway & Light Company has enjoined the enforcement of the ordinance. Efforts of the City Solicitor to secure expert testimony to support the 5-cent rate have proven disappointing.

KENTON.—The Westinghouse Electric & Manufacturing Company, Pittsburg, Pa., is reported to be preparing plans and estimates for improvements and extensions to the plant of the Kenton Gas & Electric Company, recently purchased by Kerlin Bros., of Columbus. It is stated that about $50,000 will be expended.

NEWARK.—The Licking Light & Power Company, of Newark, has been incorporated. The concern has been reorganized by Melville Gillett, of Newark, and Congressman Beman J. Dawes, of Marietta. The capital is $300,000, one-third of which is preferred stock. In addition to Gillett, the incorporators are Henry G. Bohl, John P. Maynard, W. G. Bathalow and J. W. Danford.

COLUMBUS.—The municipal light plant has commenced to furnish electric current for the lighting of nearly the whole city. Under the new plan, there will be only one stretch in the city not lighted by the municipal plant, this being the distance between the court house and the Union Station in High Street, where the arches are still lighted by the merger company. It is the intention to permit the company to continue the lighting of the arches under yearly contract. A number of additional lights will be added to the municipal service, the plan contemplating eventually the use of 1,950 lamps.

OREGON.

SEASIDE.—The Seaside Electric Company has been incorporated by Dan. J. Moore, A. S. Froeled, and others.

ASHLAND.—Milton Berry, City Recorder, writes that the citizens voted to issue $50,000 bonds for constructing a municipal electric light plant.

OREGON CITY.—The Clackamas Power Company has been incorporated by J. T. Apperson, H. E. Cross, C. H. Dye, E. G. Canfield and I. B. Sanborn; capital, $25,000, with the object of erecting dams and developing power.

PENNSYLVANIA.

SHIPPENSBURG.—The Council has appointed a committee to solicit correspondence and secure information relating to cost and expense of constructing and operating a municipal electric light plant. The present contract does not expire until October, 1906.

GIRARDVILLE.—Bids will be received until Aug. 7 by M. J. Walsh, Chairman Light Committee, for lighting the streets with about 25 lights of the highest power for a period of 5 or 10 years, commencing Jan. 1, 1906, the annual cost not to exceed $1,500. Robt. Pryce, Clerk Town Council.

WAMPUM.—An election will be held in Aug. to vote on issuing $12,000 bonds to be used to build a gravity water system, and to equip the borough with electric light, power to be procured from the Ellwood Power Company, of Ellwood, 5 miles distant. G. B. Zahniser, Clendennin Blk., New Castle, is engineer for the water works.

LANSDALE.—Contracts for rebuilding the electric light plant have been awarded as fol-

lows: To the Erie City Iron Works, Erie, Pa., for the steam equipment, including one boiler and two engines and all connections; and the Fort Wayne Electric Works, Fort Wayne, Ind., for two dynamos of 125-kw. capacity and switchboard with all equipment and 60 enclosed arc lamps.

SOUTH CAROLINA.

ANDERSON.—At the annual meeting of the stockholders of the Anderson Water, Light & Power Company, Dr. S. M. Orr was re-elected president.

COLUMBIA.—A merger has been completed of the Columbia Electric Railway, Light & Power Company and the Columbia Water Power Company, and Edwin W. Robertson has been elected president of the new company. A new mortgage will be executed to cover a bond issue for the purchase of the water power company, leaving a considerable sum for contemplated improvements.

TENNESSEE.

CLARKSVILLE.—The Consumers' Electric Light, Power, Heating & Refrigerating Company is reported formed here to construct an electric plant.

TIPTONVILLE.—Papers are prepared for a 15-year franchise for an electric light plant to be in operation by September 1, 1905. It is understood that Memphis capital is behind the promoters of the new company.

CLARKSVILLE.—A movement has been inaugurated here to organize a new electric light and power company. The company will be known as the Consumers' Electric Light, Power, Heating & Refrigerating Company.

BOLIVAR.—Bids will probably be received early in August for the construction of water works and an electric light plant, for which bonds to the amount of $20,000 have been sold. Engineer, Granberry Jackson, Nashville.

KNOXVILLE.—In regard to the proposed power plant of the Knoxville Power Company on Tennessee River, Engineer Jas. B. Cahoon, of New York, states that it will probably not be financed before fall and nothing will be done until then.

CHATTANOOGA.—Local press reports state that plans are about completed for the proposed dam and power plant for the Chattanooga-Tennessee River Power Company, to be constructed under the supervision of Major Henry C. Newcomer, and work will begin about Sept. 1.

CHATTANOOGA.—The preliminary surveys for the proposed big water-power electric plant on Little River, near Blanche, Ala., are now being made. H. T. Henderson and Samuel Henderson, of Durango, Colo., are the principal promoters of the enterprise. It is expected that the work will cost between $1,000,000 and $1,500,000. The company proposes to develop sufficient power to furnish the industrial plants of Gadsden, Alabama City and Attalla, Ala.; Rome, Ga., and probably Anniston, Ala. The proposed plant will be located 34 miles from Gadsden, 27 miles from Rome, and 72 miles from Anniston.

CHATTANOOGA.—W. B. Spencer, 16 Exchange Place, New York, N. Y., Assistant Engineer of the Chattanooga-Tennessee Power Company, of which J. C. Guild and C. E. James are the promoters, writes that bids for construction of the plant, which will cost about $1,500,000, will be received in about 4 weeks. This water power electric plant, which will be constructed on Tennessee River, about 12 miles from Chattanooga, will develop about 50,000 horse-power. The lock will be about 60 feet wide, dam 40 feet high and 1,200 feet long; power house to be adequate for 14 units of 3,000 kw. each. Transformer house and other buildings will be erected. John Bogart, Consulting Engineer, 16 Exchange Place, New York, N. Y.

TEXAS.

CENTER.—The electric light plant owned by Fleshman & Harkrider has been destroyed by fire.

BONHAM.—The Bonham Electric Light & Power Company's plant was sold to a Dallas firm, of which J. F. Strickland is president.

CLARENDON.—The Clarendon Water, Light & Power Company has been organized with a capital stock of $50,000. L. W. Chase is one of the incorporators.

COLUMBUS.—The Columbus Light Company has been organized at Columbus for the purpose of operating an electric light and power plant. The company has a capital stock of $10,000.

SAN ANTONIO.—C. A. Zilker, vice-president of the Southern Ice & Cold Storage Company, of San Antonio, is promoting the organization of a company to install an independent electric light and power plant for San Antonio.

AUSTIN.—Mayor W. E. Shelley, of Austin, is negotiating with the representatives of a syndicate of Boston capitalists for the sale of the ruins of the old dam across the Colorado River here, and the sale or lease of the municipal water and lighting plant. This dam was built about ten years ago at a cost of $1,000,000, but was destroyed by a flood in the river in 1900. It supplied power for operating the water works and electric light plants of the city.

UTAH.

COALVILLE.—The citizens have voted to issue $10,730 bonds for an electric light plant.

PROVIDENCE.—It is proposed to construct an electric light plant, at a cost of $12,000. A. M. Hammond is town clerk.

EPHRAIM.—Bonds to the amount of $15,000 are reported sold, to be used for the construction of an electric light plant.

VERMONT.

BRISTOL.—The Lake Dunmore Power & Traction Company, which recently absorbed the Bristol Electric Company, is constructing a steam auxiliary plant and has completed surveys for a large dam to be built about a mile above its present plant in New Haven River. H. W. McIntosh, of Burlington, is the engineer.

ST. JOHNSBURY.—An important business deal has just been completed by which the St. Johnsbury Electric Company acquires the Ide water power at Passumpsic, and will erect at once a modern electric light station, using the water power to its fullest capacity. The Electric Company will then have three stations, one at the dam at the Center, which now supplies the village with arc and commercial arc lights, the station at the Belknap dam, and the new one at Passumpsic.

VIRGINIA.

RURAL RETREAT.—W. C. Lawson contemplates installing an electric light plant at the Rural Retreat Mills, and will probably furnish light and power to the town.

FREDERICKSBURG.—The Rappahannock Electric Light & Power Company has been formed by J. B. Ficklen, president; A. D. Tapscott, secretary. The capital is $10,000.

JOHNSON.—There has been talk of installing the electric plant at Ithiel Falls and it is understood that the town has purchased the water power of Rev. I. T. Johnson, and that the plant is to be established there.

RICHMOND.—The Water Commission has adopted the report of the sub-committee endorsing the proposed new electric light plant at the old pump house, to cost, for building, $12,000; for electric pumps, motors, transformers, switchboard, transmission line, etc., $25,000, and for a main between pump house and new reservoir, $52,000.

POULTNEY.—The Lake Dunmore Power & Traction Company, which recently absorbed the Bristol Electric Company, is building a steam auxiliary plant and has completed surveys for a large dam to be about a mile above its present plant on the New Haven River near Bristol. The former company operated its plant only a portion of each day, but the new concern proposes to furnish power 24 hours each day.

WASHINGTON.

TACOMA.—The City Council granted a franchise to the Seattle-Tacoma Power Company.

KENNEWICK.—C. E. Wood, of Genesee, has petitioned Council for a franchise for water works and an electric light plant.

PORT TOWNSEND.—John Seiderbaum has petitioned Council for a franchise for a gas, electric light and heating plant.

SNOHOMISH.—The plant of the Snohomish Electric Light & Water Power Company is reported to have been destroyed by fire.

FORT LAWTON.—The Seattle Electric Company, of Seattle, has submitted the lowest bid for installing electric light at Fort Lawton, for $13,576.

TACOMA.—The Fire and Water Committee has recommended the passage of a resolution authorizing the City Clerk to call for bids, to be submitted by Oct. 1, for the construction of a water-power generating plant of not less than 5000 horse-power and not more than 10,000 horse-power.

WALLA WALLA.—An ordinance has been introduced in Council granting C. M. Maxwell and H. Day Hanford, of Seattle, a franchise to construct and maintain an electric light and gas plant in Walla Walla. It is proposed to organize a company to be known as the Walla Walla Gas & Electric Co.

TACOMA.—The City Council on July 12 adopted the resolution authorizing the City Clerk to procure bids for the construction of a steam power electric generating plant, to be established if possible within the city limits. All bids to be submitted for a generating plant of at least 5,000 horse-power, and not more than 10,000. A resolution was previously adopted for a water power generating plant. The idea is to secure bids on all kinds of plants for generating electric current.

WYOMING.

EVANSTON.—The local electric light company has applied for a franchise for laying steam pipes, to supply heat to business houses.

LARAMIE.—The City Council is reported to have granted Alfred E. Kalter, of Indianapolis, a franchise for an electric light plant.

CANADA.

NAPANEE, ONT.—The citizens have voted to issue $35,000 bonds for a municipal electric light plant.

NIAGARA FALLS, ONT.—The diverting dam in the Niagara River, which has shielded the intake works of the Ontario Power Co. during their construction, is now being rapidly and successfully removed. This dam was built in 1903, extending out from shore above the upper line of rapids and laying dry an area of about 18 acres, including the water courses about the Dufferin Islands. In June water to operate the first 10,000 h.p. unit was admitted to the forebays by a sluiceway cut through the dam. This diverting dam is about 900 feet long, 250 feet of it extending out from shore at nearly a right angle, and the remainder running at an angle down the stream, thus turning the water out toward the middle of the river. It is built of bottom cribs 31 feet long, 16 feet wide and 11 feet deep, which were floated into place, and sunk by loading with stone. No puddle was used, but the dam was made tight by bags of cement placed on the rock bed of the river against the upstream face of the cribs, and by double-lapped tongue and groove sheet piling driven into these bags. A diver, protected from the swift current by a timber shield, placed the bags of cement and fitted the piling to conform to the irregularities of the river bed. This construction has proven very successful, as very little water has leaked through the dam. The removal of the dam is accomplished by unloading sections or cribs one at a time, and by swinging as on a hinge in toward the shore, into the quiet water behind the remaining portion of the dam. The stone fill is removed by common labor, no diver being required. An interesting, and in fact surprising, feature of the operation of removal, is that after a crib is unloaded, in spite of the terrific force of the current, it seems almost as stable as before, although held in place only by the small quantity of cement above mentioned. The combined power of a hoisting engine on shore and a derrick on the dam is required to loosen the cribs from the bed of the river, after which they swing easily around toward the shore.

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MODERN FRENCH HYDRO-ELECTRIC GENERATING STATION.

THE SAUT MORTIER TRANSMISSION PLANT.

BY F. M. BRYAN.

A good example of the use of a hydro-electric plant for distributing current over a wide area of country is found in the Saut Mortier plant. It is located in the Jura region, a mountainous district lying in the eastern part of France and next to Switzerland. What is to be noticed in the present case is the use of current over an extensive region comprising a great number of small towns and villages, where manufacturing industries are carried on in many small factories and home workshops. Watchmaking, for instance, is an industry which takes a great number of small motors, and there are also many turning mills, diamond polishing establishments, etc. Where hand, steam or water power were formerly used, electric motors are employed for the most part, since the erection of the present plant, and the supply of current has proved a great benefit to the region. The electric lighting of the different towns is carried out at the same time.

FIG. I.—HYDRO-ELECTRIC POWER PLANT AT SAUT MORTIER.

The large hydraulic plant erected on the Ain at Saut Mortier is among the most important of the Alpine region. The Ain River is a rapid mountain stream, which rises in the Jura Mountains and runs through several districts, emptying into the Rhone. It is subject to great fluctuations and special measures had to be taken to provide for this when designing the hydraulic work of the plant. The Union Electric syndicate is operating the Saut Mortier plant, and the whole of the electric equipment was installed by the Oerlikon Company. As the river could not supply all the water needed to operate the turbines, use was made of Lake Chalain, a small body of water forming a natural reservoir, which is separated from the stream by only a mile or so of alluvial soil. The level of this lake is about 110 feet above that of the river. The lake affords a basin of one square mile and is 120 feet in depth. During droughts it can be called upon for a good supply, so that the present hydrau-

lic plant can develop 3,000 horse-power with a 60 foot head of water.

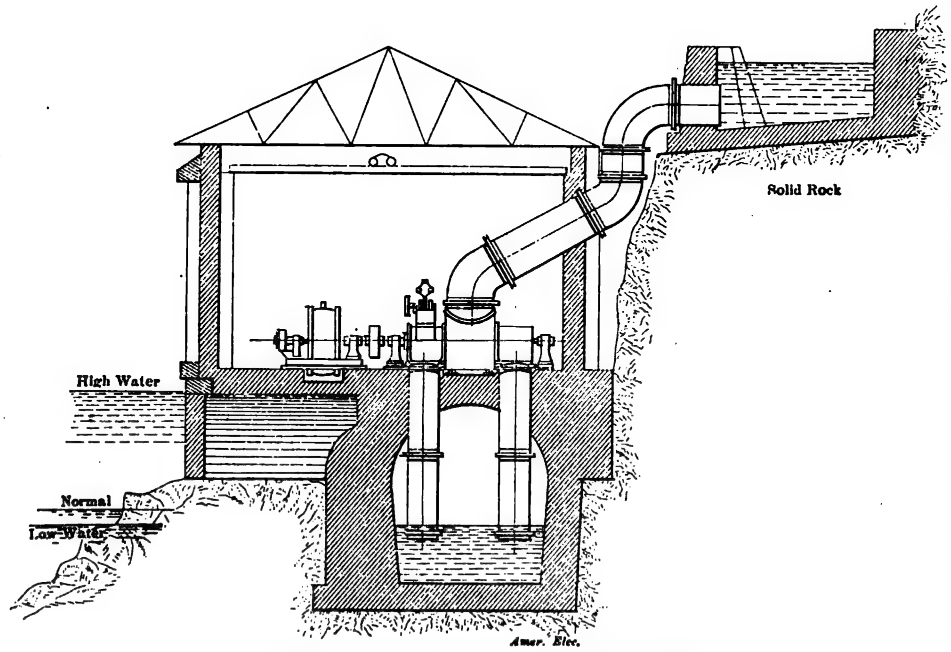


FIG. 2.—CROSS-SECTIONAL ELEVATION OF POWER HOUSE.

The lake is connected with the river by an underground canal, which has a series of gates for regulating the supply. The remainder of the hydraulic work for the Saut Mortier plant comprises a dam across the Ain, which is 32 feet high and 150 feet long, a masonry canal leading from the dam about a mile in length, which is covered over for a distance of 400 feet, and is open for the rest of the way, and an underground passage leading to the turbine station. An overflow canal provided with gates is placed above the station to adjust the height of the water.

The dam is located at a narrow part of the river, where it has worn a deep gorge in the cliffs, on a rock foundation. The top width of the dam is about 12 feet. The upper part of the dam has been constructed so that the highest load will not exceed 12 tons per square foot. On the right hand side of the dam are three locks for navigation, and at this point the main canal for the station starts. The main flume, which leads from the dam to a point above the station, has a rectangular section, and is 15 feet wide and 9 feet deep. This canal is built of concrete and is partly open and partly covered. At several points the canal has overflow gates for regulating the level. At the end above the turbine house it empties into a collecting basin built of masonry. The bottom of the basin is about 60 feet above the level of the station floor. The penstocks, of which there are four, are built of 8 millimetre steel and measure 70 inches inside diameter. Fig. 2 shows the disposition of the basin, penstocks and wheels, and Fig. 1 shows the exterior of the station. Some difficulty was experienced in constructing the station, as the river is bordered by high banks with but little level ground. The hydraulic work had also to be designed so as to provide for the sudden rises which are very frequent in this mountain stream. The building, which measures 150 by 50 feet, has been constructed for five turbo-generator groups. At present there are four of these units installed. Concrete is used for the foundation and walls and the floor of the main room is tiled. The cables leading from the generators are provided with conduits covered with flat stone. A 15-ton overhead crane runs along the main room. The Saut Mortier plant is in constant operation except for a stop of an hour and a half at

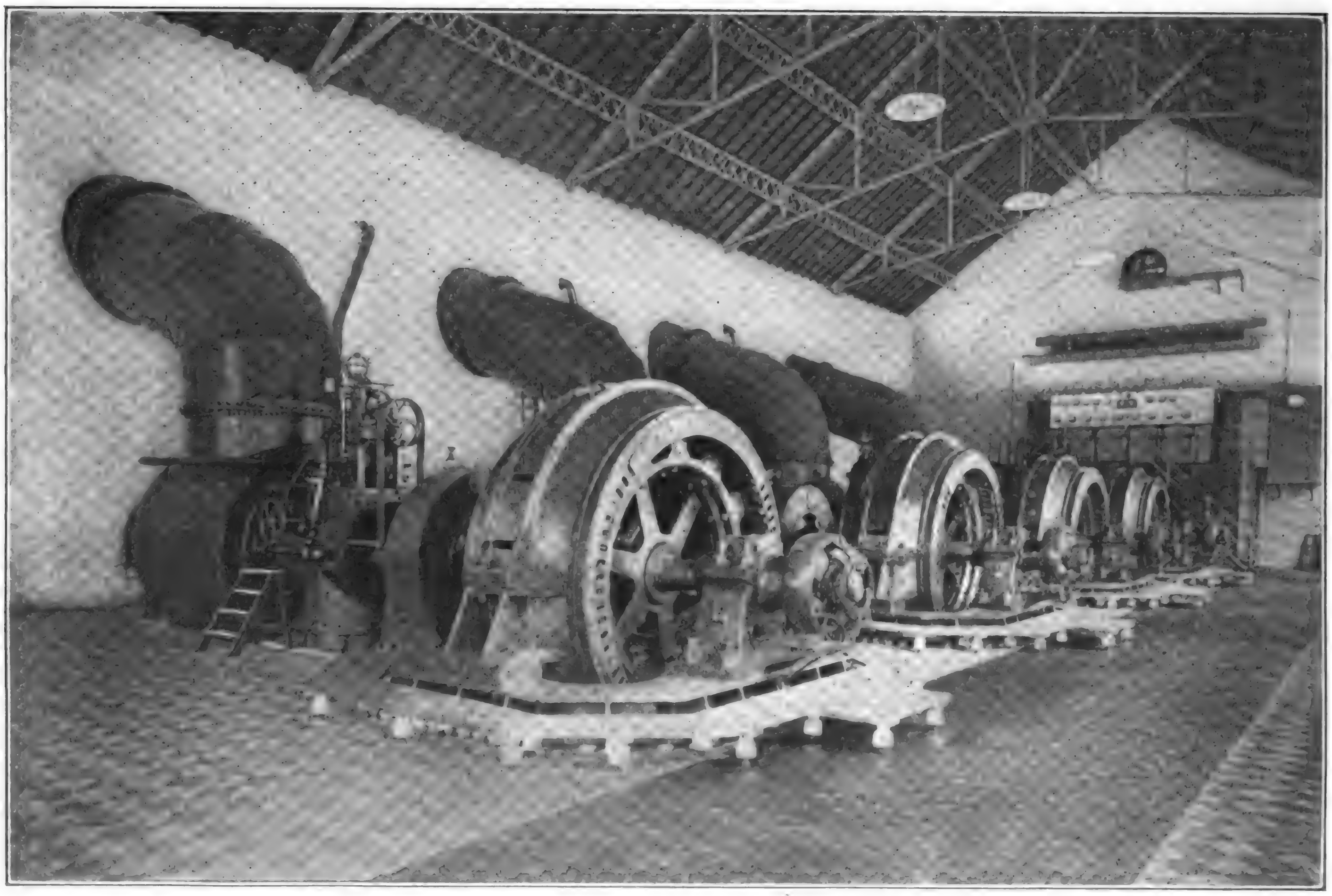


FIG. 3.—INTERIOR VIEW OF THE STATION AT SAUT MORTIER.

midday and again for six hours on Sundays.

The general appearance of the turbines, which have been built by Piccard & Pictet, of Geneva, will be observed from Fig. 4. These wheels are of the horizontal shaft pattern and have been specially designed so as to allow for sudden variations of the water supply. They work on a head of water averaging 18.4 metres (60 feet), and develop 700 horse-power each, at 250 r.p.m. At certain periods of the year when the fall is reduced to 40 feet, the turbines furnish 500 horse-power, or more. Raffard elastic couplings connect the turbine shafts to the alternators. The main shaft of the turbines is placed 22 feet above the level of the tail race, which is an advantage in case of high water. Each turbine of the series is built with two wheels in the same outer casing. The water is discharged from the wheels by a double piping, which is placed on each side of the main chamber. The outside diameter of the turbine wheels is 42 inches. They are surrounded by a set of movable inlet vanes which regulate the water supply. A Piccard hydraulic governor is provided for each turbine. It consists of a hydraulic motor whose movements are controlled by the speed of the wheel. The motor is connected with the movable vanes, opening or closing them as the speed rises or falls. In practice the speed of the turbines is kept constant within very close limits.

The alternators are of the Oerlikon inductor type. They deliver 50-cycle, three-phase current at a terminal voltage of 7,500, with a speed of 250 r.p.m. The revolving field is made up of a cast-steel rim bolted to a cast-iron wheel having 6 spokes. The spokes are stiffened with strong webs. The outside diameter of the rim is 1,890 metres, its width 920 millimetres and its thickness 125 millimetres. A double set of laminated pole-pieces is disposed around the periphery of the wheel, and bolted to the rim. The height of the pole-pieces is 150 millimetres, and the width of each pole, measured parallel to the shaft, is 235 millimetres, while the peripheral length of the pole face is 230 millimetres. The outer diameter of the revolving field is 2.192 metres, and the air-gap is 4 millimetres. Between the two halves of the field is a winding which passes around the main wheel and forms a double magnetic circuit. This winding is of copper band, having a section of 60 by 2 millimetres. The field winding is made in two halves, and each half contains 83 turns. The two halves of the winding are connected in series upon the exciter circuit. The current is conveyed by a pair of rings mounted on the shaft. The total number of turns in the field is 166, and the total weight of copper is 13.7 tons. The entire revolving part of these alternators weighs 84 tons.

The outer body of the machine which contains the armature winding is formed of a cast-iron ring, built in two parts. The ring has a trapezoidal section in each of the halves and the latter are connected across by a cylindrical part having a series of 12 ventilating holes. The outer diameter of the main casting is 3.090 metres and the width, 0.900 metres, while the inner diameter is 2.540 metres. Inside the casting is fitted the laminated part which carries the coils. To correspond with the field, the armature is built in two parts, and each half of the main casting thus carries a similar laminated ring. The latter is bolted to the casting and one of the rings is disposed so that it can be taken out, if necessary. The outer diameter of the laminated ring is 2.540 metres, and its thickness is 170 millimetres. The armature bore is 2,200 millimetres, and the width of each ring, 250 millimetres. The coils are placed in 72 slots, two slots per pole and per phase. There are two lathe-wound coils laid in each slot. The coils are insulated with micanite, and are held in place by fibre strips. Each armature coil is made up of 33 turns of two 3.2 millimetre copper wires in parallel. The coils of each phase are connected with the corresponding coils which lie in the slots of the other ring. The total weight of copper in the armature winding is 600 kilogrammes. The fixed portion of the alternator weighs some 17 tons.

Under the body of the machine are placed the main connections for the current and these are completely protected. From here the cables pass in conduits under the floor to the switchboard. The exciting current at no load is about 56 amperes. When under the usual running conditions of 50

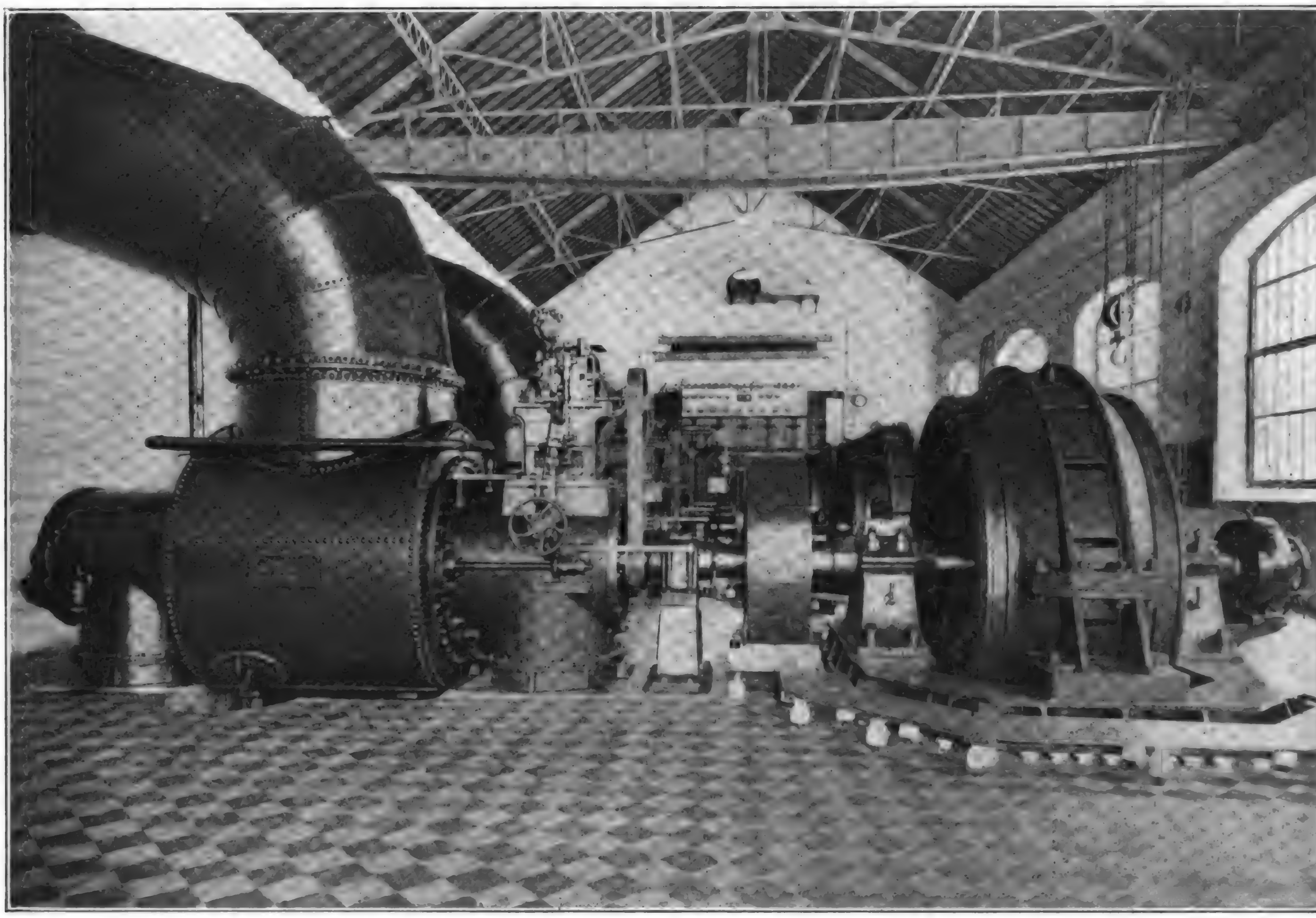


FIG. 4.—VIEW THROUGH THE CENTER OF THE STATION.

amperes per phase and a power factor of 0.8, the exciting current is 90 amperes. The efficiency of these alternators at normal load with a power factor 0.8, it is stated to be 93.5 per cent. The losses are given as follows: Losses at no load, 24,300 watts; heat loss in armature, 10,300 watts; in field, 1,810 watts; total loss in the machine, 36,410 watts.

As will be observed, the exciters of the machines are mounted on the end of the shaft, outside the main bearing, and are held upon a bracket. The exciters are 4-pole, shunt-wound machines with drum armatures, and have a capacity of 3.6 kilowatts at 30 volts.

The switchboard installation of the Saut Mortier plant has been well carried out. In order to provide sufficient space for the great number of circuits which are used here, the switchboard is built in two stories and is placed against the end wall of the station. The upper part contains the marble switchboard proper, while the lower part has most of the apparatus and the bus-bar connections. A platform is placed in front of the main panels which carry the hand-wheel and levers, so that the attendants can overlook the dynamo room. An iron structure measuring 25 feet long and 15 feet wide forms the main platform, and serves to hold the upper part containing the panels. An iron staircase leads up to the main platform on either side. The upper story consists of an iron frame which carries a set of white marble and xylolith panels for holding the measuring instruments. The switchboard is 15 feet long and 7 feet high and stands 5 feet from the wall of the station. There are ten panels in all and each has a corresponding set of instruments. Under the main panels is another set of panels which serves to hold the connecting wires on the back, while in front are mounted the levers and hand-wheels connected with the switching apparatus in the lower story. All the switchboard panels, with the exception of the upper middle one, carry ammeters for the alternators and feeder circuits. The latter panel has a general voltmeter which can be connected to the different circuits by a voltmeter switch. Behind the panels are the instrument wires and the lightning arresters.

The lower chamber containing the switching apparatus is accessible from the ends, and is divided into two parts by a central passage. The side next the hall carries the high tension switches for the machines, as well as the resistances, the reducing transformers for the measuring instruments and the cables coming from the alternators. On the side next the wall are the safety devices for the different feeders of the line.

The high tension switches of the feeder circuits are placed above the middle passage on the ceiling. Here are placed switches and special safety devices which have been recently designed by the Oerlikon Company. These devices work on the blow-out principle, having the arc enclosed in a chamber.

The main lines which run from the Saut Mortier station are four in number and they cover a considerable extent of territory in the Jura region, running through or near many towns of large size or smaller villages which are fed either by the main lines or by branch circuits. Of the four main lines at high voltage, the first circuit runs through the country for a distance of 16 miles to the large town of St. Claude, which is an industrial center of some importance. The overhead line consists of two separate circuits, each having two wires of 8 millimetres. Another main line runs from the station as far as the town of Nantua. For a distance of 6 miles the line uses three 8 millimetre wires, and from this point a double circuit branches out. The first branch leads to Nantua, 12 miles off, with a circuit of three 6 millimetre wires, while the second branch of three 4-millimetre wires leads to the town of Viry, 5 miles off. From the latter point there are a number of shorter branches which lead to the surrounding localities. The third line from the station is 5 miles long, and goes as far as the town of Arinthod, with three 4-millimetre wires, while the last circuit, leading for 3 miles to Cernon, runs from there to Moirann, 6 miles, with 4-millimetre wires. The total length of the high tension overhead lines starting from Saut Mortier may be reckoned at 70 miles. On the same poles is mounted a telephone circuit. There are in all some 4,000 poles now in use on the different lines, and these vary from 30 to 40 feet in height. They

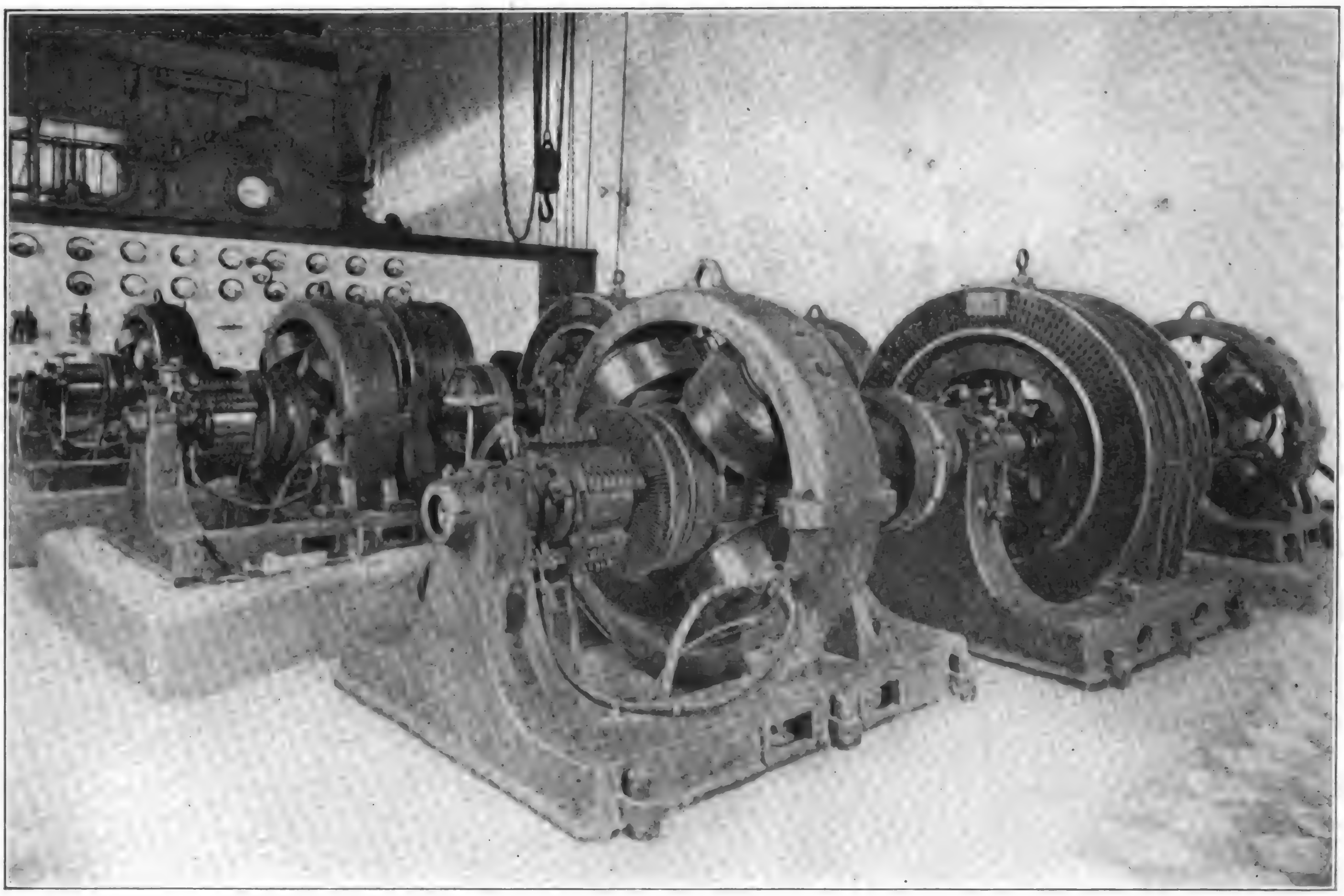


FIG. 5.—INTERIOR VIEW OF THE SUB-STATION AT ST. CLAUDE.

are treated for the most part with sulphate of copper or zinc chloride, and are sunk six feet in the ground.

Lamps and motors in the different towns are supplied by secondary circuits, and the transformers which are used here are installed in kiosks built of cement and located at the proper points. Each of the transformer posts has a similar outfit comprising a 3-pole switch for the high and low tension circuits, safety fuses, and lightning arresters for primary and secondary circuits. The lines from the transformer houses are overhead in all cases. A 70-kw. Oerlikon transformer is generally used on the different posts.

In order to supply current for the locality of St. Claude, where the number of lamps and motors is considerable, a sub-station has been erected, containing a number of motor-generator groups. Fig. 5 is a view of the St. Claude station and shows the main room, with the motor-generators in front and the main switchboard in the rear. The sub-station consists of a two-story building, each floor covering some 250 square yards. Three motor-generator sets are mounted in the dynamo room, and each of these groups consists of an Oerlikon three-phase motor having a generator mounted on either side of it and connected by a flexible and insulated coupling. The three-phase motors are of the most recent construction and operate at 590 r.p.m. Their capacity is 150 horse-power each. Transformers in the station lower the line voltage to 200 volts for the motors which work on 50 cycles. The bore of the stator is 900 millimetres, with a length of iron of 230 millimetres. In each of the 130 slots which the laminated ring carries there is placed a cable formed of 14 bare copper wires of 3 millimetres. The rotor of these machines has an outside diameter of 898 millimetres and carries 180 slots. In each of the slots is laid a cable formed of six 4-millimetre bare copper wires.

The direct-current machines on either side of the motor are of the standard Oerlikon 75 horse-power pattern, with a 4-pole field and a drum armature. These machines work at normal speed of 590 r.p.m. and deliver current to the secondary circuits at 200 volts. The diameter of the armature is 470 millimetres and the length of iron 320 millimetres. The armature has 117 slots, each containing two cables formed of three 4-millimetre wires. The field diameter is 486 millimetres.

The apparatus in the St. Claude station comprises four main, three-phase transformers which are used to supply the motors of the groups just mentioned. The high tension lines coming to the transformers are supplied with safety fuses and lightning arresters. The switchboard carries switches for the alternating and direct-current circuits, which leave the station for supplying lamps and motors in St. Claude. The three-phase lines are used for the motors throughout the locality, while the direct-current lines serve for the public and private lighting.

A considerable number of three-phase motors are used in the different industries at St. Claude and in the neighborhood, and the number is constantly increasing. The three-phase circuit supplies the motors at 200 volts. These latter are of Oerlikon make and range in capacity from one-half to 35 or 40 horse-power. At the present time there are upward of 100 motors in use. The lamp circuits in the different localities fed by the Saut Mortier plant are supplied with three-phase current at 120 volts. In St. Claude there are also a number of lamp circuits which work on direct current at 200 volts, with two lamps in series. It is estimated that there are upward of 7,000 lamps used throughout the region.

PISTON ROD PACKINGS.

BY R. T. STROHM.

The common means of obtaining a steam-tight joint around a piston rod or a valve stem is by the use of a stuffing-box and gland, as shown in Fig. 1. The stuffing-box *A* consists of a circular projection cast with the cylinder head, and having a greater internal diameter than the diameter of the piston rod, so as to leave an annular space between the sides of the stuffing-box and the rod, into which several layers of packing are pressed. The gland *C* is made of such proportions that the cylindrical portion surrounding the rod will slide easily into the bore of the stuffing-box. This

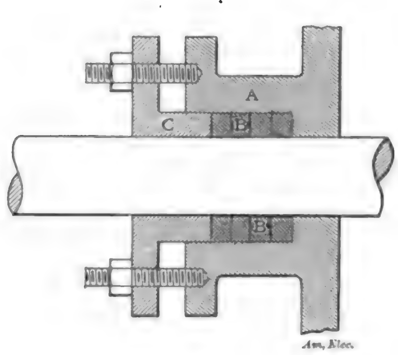


FIG. 1.

gland is forced down upon the packing rings by means of bolts and nuts which draw it toward the cylinder; the packing is thereby compressed and forced to expand laterally, causing it to fit closely around the rod so as to prevent leakage of steam.

A good piston rod packing must embody certain essential features. In the first place it must be pliable enough to adjust itself readily to the shape of the rod. Unless this is the case, leakage is certain to occur. It must also be possessed of reasonable durability. There are three deteriorating agencies at work on the packing when it is in service in the stuffing-box. First, it is subjected to the pressure of not only the steam, but also the gland; second, it is subjected to the heat of the steam, the temperature which it must withstand on this account depending upon the steam pressure; third, it must bear the friction and consequent wear due to the reciprocating motion of the rod.

In order to withstand comparatively high pressures with any degree of success, a fibrous packing must possess a certain "body," or firmness. Otherwise, it will be too easily disintegrated and liable to be torn out of the stuffing-box by the friction of the rod combined with the pressure of the steam. But, on the other hand, pliability must not be sacrificed to obtain firmness.

In order to insure pliability, the packing must not dry out or harden. As soon as this occurs there will be increased friction, and the heat thus generated will make the packing still harder and drier, with the result that it will eventually seize the rod. This results in scoring and fluting, for, in spite of the fact that the fibrous materials incorporated in ordinary packings are softer than metal, they are able, when dry and hard-baked by heat, to cut and ruin even a steel piston rod.

All fibrous packings include lubricants of some sort in their make-up, and these serve both to give the requisite pliability and to prevent undue friction with the rod. The lubricants thus employed are mineral oils and graphite. It should not be necessary to put great pressure on the packing, by screwing down the gland, in order to secure a steam-tight joint. Undue pressure in this way not only adds to the friction and wear but shortens the life of the packing and that of the rod.

Fibrous packings are made in three styles, one of which is known as coil packing, because it is put up in a continuous strip resembling a length of coiled rope. A sufficient number of short pieces are cut from this to make enough rings to fill the stuffing-box properly. These rope packings are usually of circular or elliptical cross-section, and vary by 1/8 inch in their sizes, although some makers supply sizes varying by 1-16 inch. In this same class may be mentioned spiral packings, which are put up in continuous lengths wound into helical form. These require to be cut also before being applied.

Another class includes ring and sectional packings. In this class the packing rings are already molded into the proper shape and size, and are ready to be applied at once to the rod. This is a very convenient form, and enables one to pack a rod quickly and easily.

The third and last comprises what are known as sleeve packings. As the name signifies, these are long sleeves of packing material; they are built up of successive rings, but all are held together in a single piece. Such a packing must be made to fit both the rod and the stuffing-box snugly when first put in place; otherwise there will be danger of leakage.

The first packings used were made of strands of flax twisted together loosely and rendered pliable by a thorough coating of tallow worked into the fibers. This was wound around the rod in a helix until of sufficient amount to fill the stuffing-box. The trouble experienced with this crude form was its rapid drying out and hardening, resulting in a blowing through of steam. To obviate this, the experiment was made of putting rubber inside the flax, so as to give the packing resilience. The re-

sults were thoroughly satisfactory. Not only was it possible to maintain a tight joint for a greater length of time, but at the first sign of leakage the gland could be screwed down a little and the natural

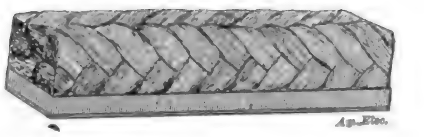


FIG. 2.

elasticity of the rubber would keep the flax against the rod at all points. The natural result of this development was the extensive and almost universal adoption of rubber as a component part of rod packings.

An extremely simple form of packing is shown in Fig. 2, consisting of flax and rubber. The flax is woven into a square braid, as indicated, and this is backed by a layer of soft rubber. When placed in the stuffing-box, the upper surface of the flax lies next to the rod, and the rubber farthest from it. Upon tightening the gland, the expansion of the rubber towards the rod causes the flax to be set up tight.

Among the coil packings, the best known is the gum-core style, a short section of which is illustrated in Fig. 3. A rectangular core of pure rubber is covered with successive layers of flax or cotton-duck, the

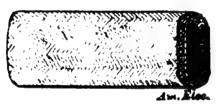


FIG. 3.

fibrous material being saturated with high-grade lubricants. The longer side of the rectangular center is parallel to the rod when the packing is in position. Rope packing is also made circular in section, the core being round, but the rectangular shape is most used, since it will permit being "followed up" to a greater extent than the round form.

Engineers differ somewhat in opinion as to how coil packing should be cut for packing a rod. Some cut the ends so that when the piece is bent into a ring around the rod the two cut surfaces are square and parallel. Others cut the coil diagonally so that the ends overlap. No matter which method is followed, the ends should not meet when the packing is first placed on the rod, but should be separated an eighth of an inch or more, because the packing when compressed by the gland and acted upon by the heat of the steam, swells, and

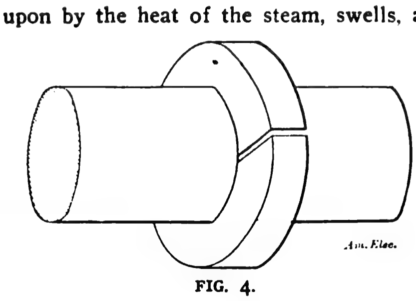


FIG. 4.

allowance must be made for this. The joints of the successive rings should be staggered, or "broken," the joint of one ring being placed diametrically opposite the joint in the next adjacent ring. In general, it will be found more satisfactory to cut the sections with beveled ends.

Where an engineer has a large number of rods to pack, and at short intervals, it will be found convenient to have mandrels of hard wood of diameters corresponding to the various rod diameters. In using rope packing the piece is simply bent around the mandrel and cut at an angle with a sharp knife, somewhat as indicated in Fig. 4. Such a device is not necessary, of course, where ring or sleeve packings are used. Instead of the wooden mandrel, a trough or box similar to the miter box used by cabinet makers may be substituted; the various lengths required for rods of different diameters can be marked along the side or edge of the box.

In case the packing is to be subjected to steam of high pressure, and consequently of high temperature, the materials used

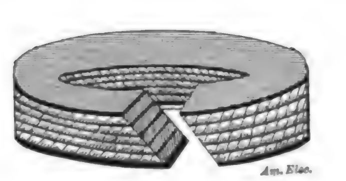


FIG. 5.

must be able to withstand such conditions. For this service, numerous combinations of asbestos and soft metal have been used in packings, the asbestos giving the necessary heat-resisting qualities, and the metal the requisite strength to resist the pressure. Usually, a soft rubber core of rectangular section is covered with asbestos threads, finely braided, alternating with layers of soft metallic wire, the whole being covered with cotton duck to prevent actual contact of the asbestos fiber and the rod. Sometimes

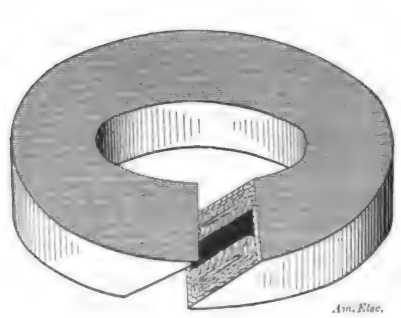


FIG. 6.

the outside layer consists of soft brass or copper wire, intended to add to the wearing qualities of the packing.

Ring and sectional packings are made in various sizes and styles to fit any diameter of rod and any size of stuffing-box. These forms of packing are very easily handled and easy to apply, since no cutting and fitting are required, if the proper size of ring has been secured. A common form of ring packing is shown in Fig. 5. It consists of alternate layers of rubber and cotton duck, thoroughly lubricated. These rings should be ordered to exact size, so as to fit both the rod and the stuffing-box snugly, because the rubber layers lie at right angles to the rod, so that there will be little expansion laterally, the greater amount being lengthwise of the rod.

The reverse is true of the ring packing shown in Fig. 6. This consists of a narrow ring of rubber lying parallel with the rod, and on either side of the rubber, cushions of cotton or flax fibers closely woven, the whole being held together by an outer

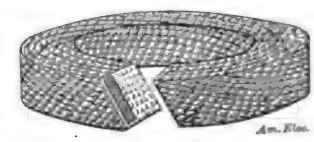


FIG. 7.

casing. It is evident that the pressure of the gland upon a ring of this character will compress the rubber center and cause the ring to expand toward the rod as well as toward the wall of the stuffing-box. Hence, rings like these should be quite free when placed in position, sliding easily into place. Subsequent expansion due to tightening up the gland will then give a good joint. Packing of this kind is especially valuable for rods which have a slight lateral motion, since the rubber center will hold the fiber cushion against the rod at all times.

The ring packing shown in Fig. 7 is intended for high steam pressures. It is composed of a rubber cushion lying next the stuffing-box wall, and a thick layer of asbestos cloth inside, the whole being encased in a cotton duck covering. The fibrous portion of the packing is saturated with lubricants to keep it pliable and to lessen the friction.

Fig. 8 illustrates a combination ring packing. The rubber expansion cushion is shown at *A*, and *B* is a facing of soft metal, around which is built up a covering of cotton fiber, *C*. The advantages claimed for this combination are great strength and durability.

The ring packings thus far described have been solid rings, made in practically one piece. There are, however, numerous diagonal ring packings, a representative type of this clsas being illustrated in Fig. 9. It will be seen at first glance that this ring has considerably greater depth than the ordinary solid ring. The upper portion, *A*, consists of braided flax, circular in form. This rests upon a wedge, *B*, composed of cotton fiber, which in turn rests against a similar wedge, *C*. The three pieces composing the ring are held in their proper relative positions by a covering of cotton duck. The two wedges, *B* and *C*,

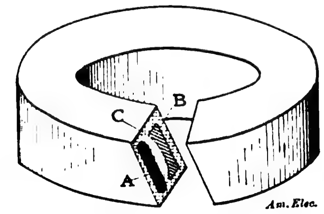


FIG. 8.

meeting along the inclined faces, tend to slide upon each other when the packing is compressed. Also, the circular section, *A*, is reduced, under the pressure of the gland, to an approximately rectangular form. The result is to force the inner surfaces of the wedge, *B*, and of the piston, *A*, against the

rod, the pressure against the rod becoming greater as the force tending to compress the packing increases.

This style of packing is designed to be self-setting. That is, it is intended to be adjusted by the steam pressure against

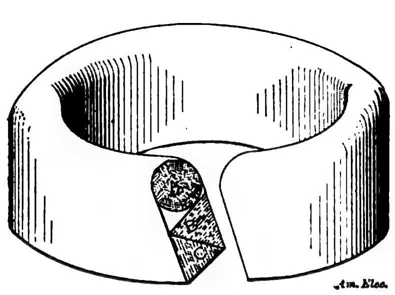


FIG. 9.

which the joint must be made tight. This means that the force with which the packing is held against the rod must vary with the varying pressure inside the cylinder, yet at all times be sufficient to prevent leakage of steam past the rod. With this style of packing any increase of pressure in the cylinder is at once transmitted to the bottom of the wedge, *B*, forcing the latter out against the rod. When, as at the end of the stroke, the steam pressure decreases, the natural elasticity of the materials causes the wedges to relieve some of the pressure on the rod. Since the friction on the rod depends upon the pressure against it, it is evident that there must be some saving by relieving the pressure at those intervals when the steam pressure is low. With the solid ring packings, the rings bear against the rod at all times with the maximum pressure required to hold the joint steam-tight, since the compression is furnished by the gland and not by the steam pressure.

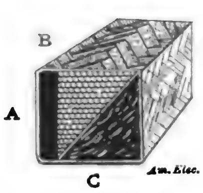


FIG. 10.

Another style of wedge packing is shown in Fig. 10. In this, *A* is a rubber cushion bearing against a wedge, *B*, made of cotton and rubber layers. The other wedge, C, is of soft flax, and it alone touches the rod. With this packing the gland is screwed up, and the expansion of the rubber sets the packing tight. It is claimed that this pack-

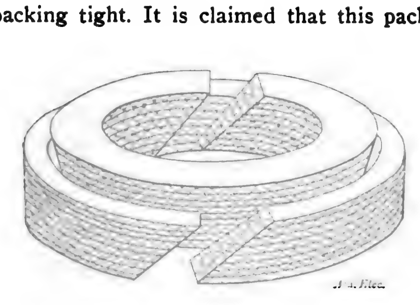


FIG. 11.

ing can be followed up until the greater part of the soft flax wedge is worn away before it becomes necessary to renew it.

Fig. 11 shows a sectional ring packing which is used to a considerable extent. It is composed of two rings, one within the other, meeting along a conical face, which makes the whole practically a wedge packing. The rings are constructed much like that shown in Fig. 5, and are lubricated with oil and graphite. Indeed, graphite is used in the composition of a large number of packings. It has the advantage of being able to fill up the slight depressions in a rod so as to present a smooth surface, while its inherent lubricating qualities are generally recognized. It is a lubricant, furthermore, which does not bake, volatilize or burn.

A sleeve packing is shown in section in Fig. 12. It is composed of alternate rings of flax packing, *A*, and cotton packing, *B*, backed by rubber, as at *C*.

In packing a stuffing-box, the box should be filled to about three-fourths its depth, each ring being pressed down snugly upon its neighbor. Then the gland should be screwed down only as tight as can be done with the fingers. Upon starting the engine,

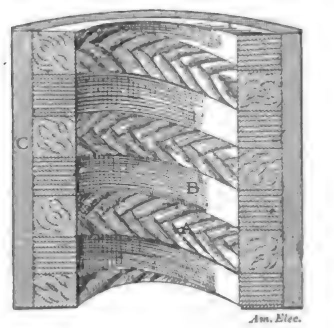


FIG. 12.

the heat of the steam will cause the packing to expand. The gland should then be loosened until steam blows through, after which it should be set up only to the point at which leakage ceases.

Failure to obtain or to maintain a leakless joint should not be taken as a sign of fault in the packing used. There are many conditions which may prevent the attainment of the desired ends, and those which exist in any given case may be due to the engine or to the engineer. If the piston rod is worn out of true, so that its section is other than circular, it will be found difficult to maintain a tight joint, because the packing will not be able to hug the rod at all points. If the piston rod is bent, the same failure will occur, because there will be a tendency for the rod to move away from the packing rings at certain points of the stroke. Again, if the piston is not properly centered, so that the piston rod fails to move in a straight line coincident with the cylinder axis, it will be found difficult to prevent leakage.

If the packing is too narrow for the stuffing-box, leakage will be a natural consequence, for only a few of the rings will touch the rod, and then only at a few points instead of entirely around the rod. The rings must fit snugly to both the rod and the wall of the stuffing-box. Furthermore, the packing should be suited to the conditions under which it is to be used. A packing for low-pressure steam should not be expected to give satisfaction with high-pressure or superheated steam. Cutting the packing rings either too short or too long may account for failure to obtain tight boxes. If the ends overlap, there will be unequal compression at various points in the stuffing-box, with liability to leakage where the pressure is least. Again, the gland may be screwed up unevenly so as to put greater pressure on one side than on the other. Or, as the packing wears away, neglect to follow it up so as to keep the rings in contact with the rod may account for poor results. These are manifestly points which cannot be charged up against the packing itself.

HIGH VOLTAGE POWER TRANSMISSION.

BY CLARENCE P. FOWLER.

The commercial feasibility with which power can be economically transmitted from any one point to any other point depends broadly upon the intervening distance. Whether this distance is within the economical transmission radius of the source of power will depend largely on the difference between the price which can be obtained for delivered power as compared with the cost of producing it. This difference must cover the cost of operating, the price of energy lost in transmission, the cost of maintenance and repairs, the interest on the investment and finally the dividends payable on the stock.

It is well known that the greater the output of all generating and transforming apparatus (within certain limits) the less will be the cost per kilowatt and therefore the less will be the interest charge per kilowatt on the investment, and as the operating force need not be materially larger for the greater output it follows that as the output is increased the operating expenses per kilowatt will be diminished also.

Both of these facts have the same significance, namely, that the larger the output of a plant that can be concentrated at one point, the greater will be the economy in the generation of electrical energy. Moreover, the larger the market that exists or that can be created at the point to which power is to be transmitted, the greater may be the distance between this point and the generating source for the reason that a greater margin will be available for investment in transmission line, owing to the saving effected by the increased size of the generating plant.

The amount of material in the line conductors depends directly upon the amount of power transmitted, when the voltage line drop and transmission distance are fixed. In other words the cost per plant kilowatt for line conductors does not diminish with increasing output, as is the case with generating and transforming equipment. Consequently, for a given voltage, line drop and transmission distance, the cost of line conductors per kilowatt transmitted will be practically the same for all amounts of power.

Since for a given line voltage, drop and transmission distance, no gain may be expected in the cost of the line conductors per kilowatt transmitted no matter what amount of power may be transmitted, and

as there appears to be a marked gain in operating expenses as well as in the interest charge on the investment per kilowatt of the generating and transforming equipment for large outputs, the transmission of power over any great distance will be commercially possible only when the market for power at the receiving end is large enough to permit such decrease in the cost per kilowatt of generating equipment as to more than offset an otherwwise prohibitive investment in transmission line.

Having taken into account some of the general economical aspects of the problem there remain some details to be considered, such as the selection of the line voltage; the arrangement and distance between line conductors; high-tension insulators, and the pole line.

Selection of Line Voltage.—Current practice seems to indicate the use of about 1,000 volts per mile of transmission, in order that the size of the line conductors may be kept within reasonable limits, but in some extreme cases two miles per thousand volts is allowed. In the matter of the selection of the proper line voltage, it is conceivable that the same may be raised to such a point that the excessive costs of transformers and line insulators will overbalance the saving effected by the reduction in size of the line conductors. The line voltage is also limited to a certain extent by losses which occur between wire and wire through the atmosphere and which experimental data have shown to be excessive after a critical voltage is reached. The losses below the critical voltage are trivial and have been proven to take place chiefly over the insulator surfaces and cross-arms. This loss is also affected to some extent by the diameter of the line wire—the smaller the wire the greater the loss which occurs with a given voltage. This seems to follow the well-known tendency of all high-potential discharges to jump or leak more freely between sharp edges and points than between rounded surfaces. In this connection the aluminum conductor (owing to its greater cross-section as compared with copper for the same conductively) would seem to present some advantage.

Arrangement of Line Conductors.—Owing to the economy in copper which the three-phase system offers it is presumed that this would be the only system considered in power transmission over any considerable distance. As to the arrangement of the three conductors, the best results are secured by locating the centres of these at the three points of an equilateral triangle, as this relation gives the least inductive reaction.

If a telephone circuit traverses the same pole line as the high-tension circuit, the former should be spiraled at intervals so that each wire of the high-tension circuit bears the same relation to the wires composing the telephone circuit in order to annul the effects of induction.

An important factor in the choice of the distance between different wires of a high-voltage transmission line is the atmospheric loss at the working voltage employed. Furthermore it is necessary to separate the line wire by such a distance that should a short-circuit be accidentally established it would not be possible for it to hold after the cause had been burned free. In this connection it must be borne in mind that an arc already established between line wires can be maintained by a much lower voltage than that required to start the arc. The best practice in this particular is to employ a separation of line conductors of about 1½ inches for each 1,000 effective volts.

High-Tension Insulators.—There are now several reliable makes of high-tension insulators on the market which are capable of taking care of working pressures up to 50,000 and 60,000 volts. There seems to be considerable difference of opinion as to whether glass or porcelain can be most advantageously employed for these higher potentials. Some of the advantages of glass insulators are: detection of a large proportion of the number of flaws by inspection; great dielectric strength; usually a somewhat more homogeneous structure than porcelain; less conspicuousness as targets on the cross-arms. The disadvantages of glass are its rather poor weathering properties and inferior mechanical strength.

The advantages of porcelain insulators are superior mechanical strength; somewhat better weathering qualities than those of glass; good dielectric strength when carefully vitrified. The disadvantages are that elaborate tests are necessary to discover flaws and the insulator forms a rather attractive target for mischievous persons.

Porcelain insulators seem to be gaining in favor owing to improvements in the methods of manufacture. In the production of these insulators for high potentials, the great difficulty encountered heretofore was to produce an insulator of sufficient size in which the porcelain was homogeneous throughout. This trouble has been overcome by making insulators in as many as three distinct parts, these elements fitting inside one another when assembled and being held together by Portland cement, forming a composite insulator of porcelain of uniform density throughout and of sufficient size to possess the necessary surface leakage dimensions for the working voltage which it is intended to withstand.

In short, whether the insulator be glass or porcelain, it should have dielectric strength sufficient to prevent the current from leaking directly through the material of which it is composed and its dimensions should be large enough to prevent appreciable leakage of current over its surface.

Pole Line.—Where the amount of power transmitted is considerable and, therefore, reliability of service is of paramount importance, there seems to be a growing tendency toward abandonment of the wooden pole construction in favor of the more substantial steel towers. With increasing voltages it has also been found advisable to construct duplicate transmission lines on separate towers spaced from 30 to 50 feet apart.

These steel towers are usually constructed of angle iron riveted together in such a manner as to form a rigid structure in the form of a pyramid, the base of which is securely fastened to a substantial foundation. The towers are usually spaced so that there are from 12 to 15 per mile as contrasted with the usual hundred-foot spacing commonly used with wooden-pole construction.

Inasmuch as there are required only about one-fourth as many steel towers as wooden poles per mile of transmission, there is only one-fourth the number of insulating points to give trouble along the line when the tower construction is used. To effect this advantage the insulator has to possess high dielectric strength for the reason that the use of metal pins brings the ground potential up inside the bell, which would not be true in the case of an insulator supported on a paraffin-treated, hard-wood pin. Moreover, since the spans are longer the insulator also has to sustain a greater mechanical strain. It is therefore evident that the use of the steel tower for long-distance transmission has been largely dependent upon the evolution of a high-tension insulator possessing the proper electrical and mechanical qualities.

The chief disadvantage of the steel-tower construction is its high initial cost, but when reliability is considered the installation cost should not prove any great barrier to its use.

When the route of a transmission line presents a rather wavy profile, as in the case of mountainous country, it is usually thought to be good practice not to follow the slopes of the land closely, but by the use of short and long towers, or poles, as the case may be, the wires may be run on smooth grade and thus avoid undue mechanical strains on the insulators and pins. In passing over a summit, the top may be rounded off by the use of relatively long poles on either side of the pole on the crest of the hill, and in this manner distributing the compression strains among several insulators, instead of confining these locally to the crest insulator, as would be the case were the line allowed to follow the natural slope of the land. Furthermore, by utilizing relatively tall poles in the valley the depression may be reduced with consequent advantagous division and reduction of the tension strain on the insulators. This feature assumes importance where composite insulators are employed; as the elements of which these are composed may be in danger of being separated by undue upward strain. The foregoing are some of the features, briefly stated, that command attention in connection with the lay-out of a high-tension transmission system.

International Association of Municipal Electricians.—At the tenth annual meeting of this association, held August 23, 24 and 25 at Erie, Pa., several papers of practical merit were read. Among these may be mentioned one by Capt. William Brophy, of Boston, on "Suggested Improvements in Fire Alarm Telegraph Systems," one by Mr. Louis Gascoigne, of Detroit, Mich., on "Underground Construction," and one by Mr. H. R. Allensworth, of Columbus, O., on "Electrostatic Effects in Telephone and Telegraph Circuits."

The Electrical Equipment of the American Thread Company

BY GEO. A. BURNHAM.

The hydro-electric plant of the Willimantic Mills of the American Thread Co. presents several unusual and interesting

FIG. 1.—DAM ACROSS THE WILLIMANTIC RIVER.

features in its electrical equipment. The plant is situated on the banks of the Willimantic River, from which a portion of the power consumed is taken. The flow of water is comparatively swift and varies within wide limits during the different seasons of the year.

The intakes to the water-wheels are from three different dams located about 500 feet apart. These dams are of solid stone masonry, and the material for construction was blasted from the river bed.

The available horse-power of dam No. 1 is 950 horse-power ten months in the year and 350 horse-power twelve months in the year. The water from this dam is diverted into a canal 17 feet wide, 10 feet deep and about 600 feet long, from which it passes through an 800-h.p. horizontal turbine and

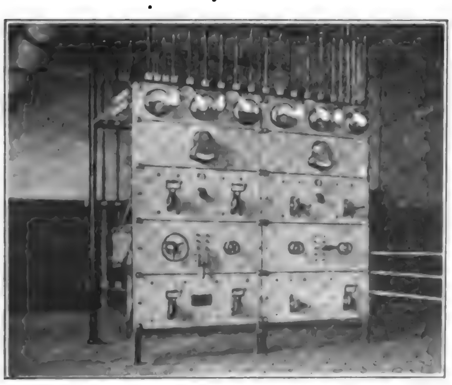


FIG. 2.—SWITCHBOARD.

is discharged through the tail race in the river below dam No. 1.

The water which is utilized in the 800-h.p. turbine, together with that which flows over dam No. 1, is backed by dam No. 2, of which the available power is 300 horse-power twelve months in the year and about 350 horse-power ten months in the year. The water diverted by this dam is passed through three 250-h.p. vertical turbines and discharged into the river below, to be again utilized by two 75-h.p. vertical turbines located at dam No. 3.

The average total available water-power is about 1100 horse-power yearly. The total power consumed is about 3000 horse-power, of which 1100 horse-power is derived from water and the remainder is furnished by steam. A view of dam No. 2 and a portion of mill No. 2 is shown in Fig. 1.

Although contrary to modern practice, the generating units, instead of being grouped in one central station, are spread out through the various mills, and in each case driven from the main shaft or the water turbines. This arrangement gives a very flexible and reliable system; also provides a way to utilize the surplus water, which would otherwise have been wasted over the "spillway," by converting it into electrical energy and transmitting it to the mills which are operated by steam.

The electrical equipment throughout was manufactured by the Stanley-G. I. Electric Manufacturing Company, of Pittsfield, Mass. The generators and synchronous motors are all of the inductor type, two-phase, 60-cycle, and operate at 2,350 volts.

The main station is located at mill No. 2 and contains a 300-kw. and a 100-kw. alternator, the fields of which are excited by two 125-volt, direct-current generators of 9 kw. and 7 kw capacity; a 45-light Brush arc machine, with its plug-board, and the main distributing board from which all circuits are controlled and to which all feeders from the outlying stations are connected.

The switchboard consists of two panels of blue Vermont marble, seven and one-half feet high, two inches thick, mounted on heavy steel angle bars. The panels are "built up" of five sub-panels each four feet long and eighteen inches wide. On the back of the board are supported two sets of bus-bars, one connected to the 300-kw. machine and the other to the feeder of all the other stations, and also to the 100-kw. machine located in the main plant. Four switches at the base of the board control the entire output of the plant. Two sub-panels carry the field switches and also the field and exciter rheostats. The field switches are of the double-pole, double-throw type, which enables either of the two exciters to be used to excite either of the fields of the two generators.

One panel supports the two main switches which connect the 300-kw. machine to its bus-bars, and another supports two switches which were originally designed for main switches of the 100-kw. machine, but are now used to tie the feeders of the outlying stations to the feeders of the 100-kw. generator located in the main plant. These two sets of switches are of the combination-slide switch and circuit-breaker type. Two static ground detectors and two voltmeter switches, by means of which the voltmeters may be connected to either phase of the system, are mounted on a panel, on which are also located the synchronizing lamps and plugs.

The top panel is somewhat narrower than the others and carries the measuring instruments, whose dials are illuminated by four double-armed pilot lamps. On the adjacent panel are located two ammeters and a voltmeter. A duplicate set is also provided on the other panel. These instruments indicate the total output of the station. The board as a whole presents a very neat appearance, being very compact and yet having ample room for the proper spacing of the wires. Fig. 2A is a diagram of the switchboard wiring, while Fig. 3 shows a diagram of connection for the feeders from the out-

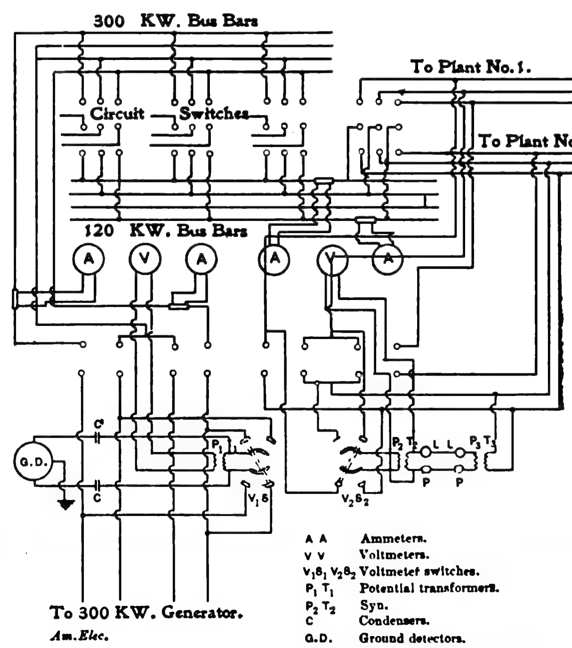


FIG. 2A.—DIAGRAM OF SWITCHBOARD CONNECTIONS.

lying stations and the switching apparatus on the main switchboard.

Plant No. 1 is located at mill No. 1 and contains a 100-kw. alternator and a 2-kw., 125-volt, direct-current generator used as an exciter. The switchboard is of the skeleton

type and is equipped with circuit-breakers, two ammeters, static ground detector, power factor indicator and the usual synchronizing appliances. Fig. 4 shows the generating outfit. This machine is used through the

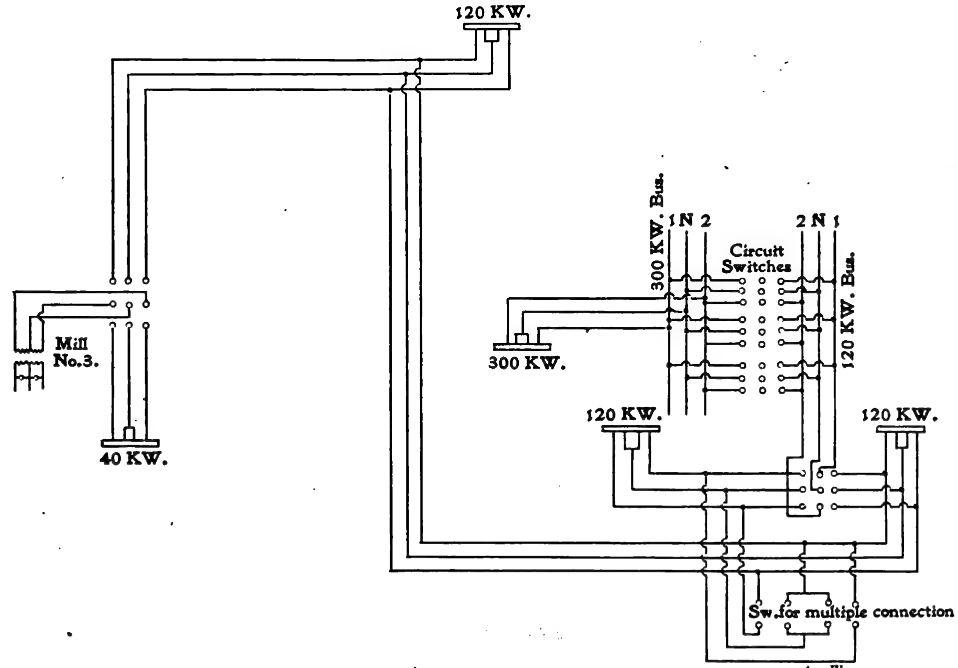


FIG. 3.—DIAGRAM OF CONNECTIONS FOR FEEDERS FROM OUTLYING STATIONS.

day to transmit power to the steam-driven mills, and during low water is used as a synchronous motor, taking current from the generators below the No. 2 dam or the steam-driven units.

Plant No. 3 is located at mill No. 3 and consists of a 40-kw. generator and an exciter of 1½-kw. capacity. This machine is driven by water-power and is used exclusively for lighting, but may be thrown in parallel with the whole system.

Plant No. 4 is located at mill No. 4, and

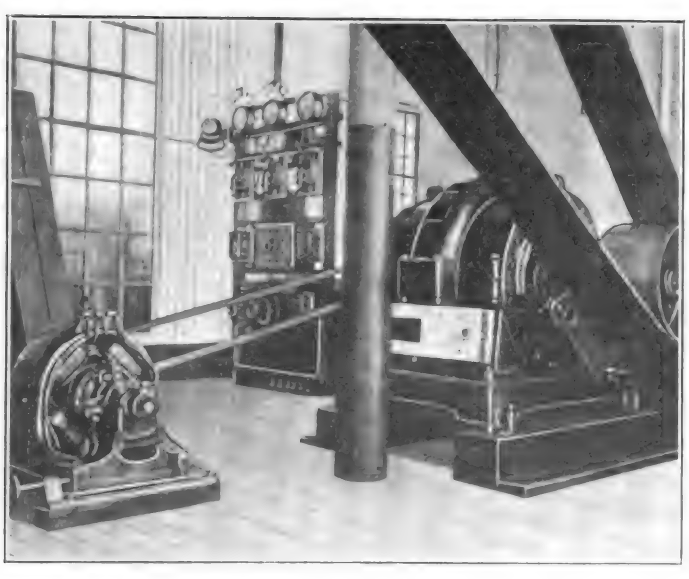


FIG. 4.—ELECTRIC GENERATING OUTFIT IN MILL NO. 1.

the generator, which is a 120-kw. machine, is driven from the main jack-shaft of the mill. The field of this machine is excited by a 2.62-kw., 125-volt, direct-current generator. The switchboard is of the skeleton type and is a duplicate of the board at mill No. 1, with the exception of the power factor indicator. This plant is steam-driven and is only operated during dry season to help out the other mills; at other times this generator is used as a synchronous motor, current being taken from the water-driven plants.

The building of a pole line to support the conductors from the various mills was a rather serious problem. The character of the soil about the mills is very rocky and in most cases solid ledge, making the construction of an ordinary pole line out of the question. This naturally resulted in placing the wires on the mills; but this has also entailed other difficulties owing to snowslides and dropping icicles, which formed in abundance during the winter months. The difficulties were overcome by several simple protective devices. The cross arms were made of 6-in. channel irons. The pins were also made of iron and bolted to the face of the channel irons, which were attached to the stone buildings by means of expansion bolts. Fig. 5 shows the method of attaching the pin to the arm. Insulators tested to 5,000 volts were used throughout the line construction. This method provides a very rigid support for the wires, and no trouble has been experienced with the arrangement.

The transformers are of Westinghouse, Stanley-G. I. and General Electric makes of the following sizes: Three 40-kw., two 25-kw., six 15-kw., five 10-kw., and several others of smaller sizes. The primaries of these transformers are connected to the middle and outer wires of a three-wire, two-phase system, and are arranged in such a manner that the load at all times is nearly balanced. Fig. 6 shows a view of one of the 40-kw. transformers, installed on the roof of mill No. 4. The secondaries of these transformers are connected to the three-wire distribution which is used throughout the mills.

Forty Couch & Seeley inter-communi-

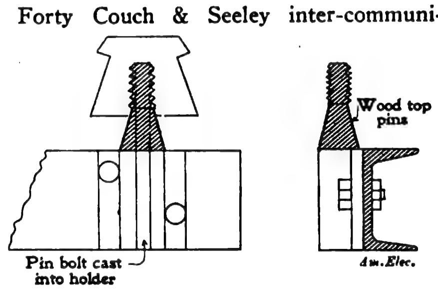


FIG. 5.—METHOD OF ATTACHING PIN TO ARM.

cating telephones are installed in the mills, in addition to several other private lines. The cables are of the paper insulated type, enclosed in a lead sheath. Branches from the main cable are all made from junction boxes, by means of which the system may be divided into six separate systems. This division makes the locating of cable trouble very easy.

The engine and water-wheel rooms are all equipped with emergency stop signals, and a separate system is installed for start-

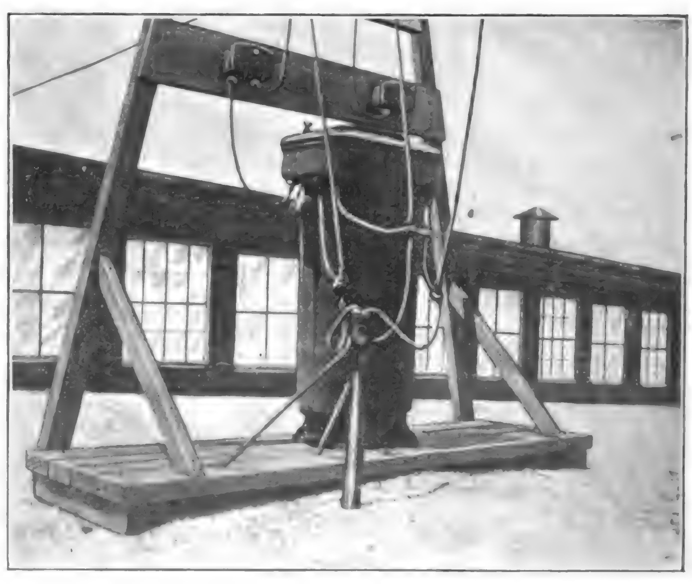


FIG. 6.—TRANSFORMER ARRANGEMENT ON ROOF.

ing and stopping. The watchman's clock system is of the battery type and consists of about two hundred stations. The signals are recorded on a four-dial clock situated in the main office. The system of electrical distribution was designed and installed by the writer.

ALTERNATING-CURRENT ELECTROMAGNETS

BY CHARLES R. UNDERHILL.

The constantly increasing use of alternating current for power as well as for lighting purposes has created a demand for electromagnets which will operate with alternating current, and since in other branches of electrical engineering direct-current apparatus has been successfully duplicated for alternating-current circuits, so may electromagnets also be made to operate on alternating currents, although more factors have to be considered in their calculation and design.

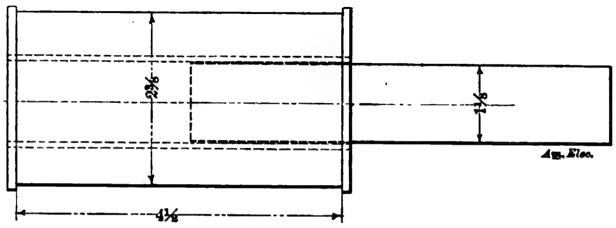


FIG. 1.—SOLENOID USED IN TEST.

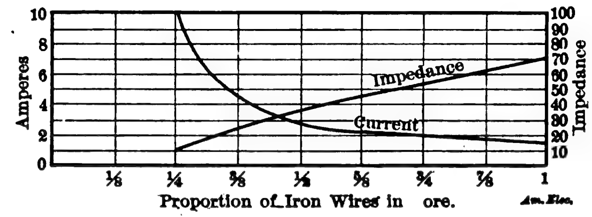


FIG. 5.—EFFECT DUE TO VARYING IRON IN CORE.

The laws governing the pull, range and heating of direct-current electromagnets are now generally known, so that the design is comparatively easy, but while the general laws of direct-current electromagnets must be followed in calculating alternating-current electromagnets, the extra factors mentioned entirely change the characteristics.

The first new factor with which we have to deal in designing an alternating-current electromagnet is inductance, which produces an effect which is the same as the counter e.m.f. in direct-current motors. Therefore, while the current is constant throughout the entire range of a direct-current electromagnet, the current will change at every point throughout the entire range of the alternating-current electromagnet ,and moreover this changes with the frequency.

It is evident that for the same line voltage, the alternating-current electromagnet will require much more current than the direct-current electromagnet, since the actual working voltage is greatly reduced in the former, owing to the counter e.m.f. of inductance. Therefore there will be fewer turns in the alternating-current electromagnet but more current than in the direct-current, in order to produce the same ampere-turns. At first though it would seem that this increased current would tend to overheat the winding, but when it is considered that the actual working voltage is much less than the line voltage on account of the inductance, it is obvious that the heating will be about the same for both electromagnets, although the winding on the alternating-current electromagnet will produce more ampere-turns for the same energy in watts than the direct-current winding, owing to the greater percentage of copper in the former winding. The fact that the alternating-current winding requires more current, and consequently a much coarser wire than the direct-current winding, also tends to reduce the cost of the wire and the cost of winding, but this is counterbalanced by the cost of the iron or steel portion of the electromagnet, which has to be laminated, whereas in the direct-current electromagnet it may be, and usually is, solid.

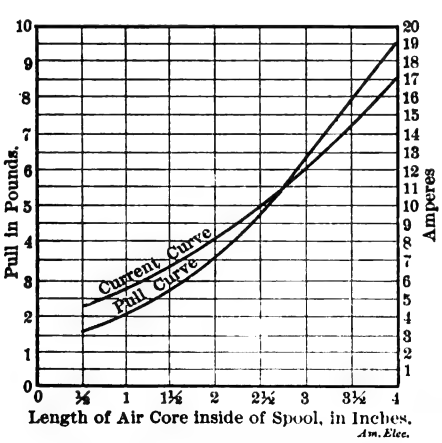


FIG. 2.—TEST OF SOLENOID IN FIG. I.

In order to show the effects due to inductance, some actual tests will be cited. The solenoid in Fig. 1 was tested with a core or plunger consisting of a bundle of soft iron wires, and Fig. 2 shows the result of a test of this solenoid on a 104-volt 60-cycle circuit. It will be noticed that as the iron is withdrawn, the current increases, thereby increasing the ampere-turns, and consequently the pull on the plunger.

The coil in Fig. 3 has a laminated core, and also three taps, making four test windings. The resistances were 0.11, 0.23, 0.36 and 0.63 ohm respectively, and the turns 131, 261, 388 and 609 respectively. Fig. 4 shows the resistance and turns and the corresponding current on 104 volts at 60 cycles. This also shows the ratio between resistance and impedance for different numbers of turns. The curve in Fig. 5 is plotted from a test of the entire winding of 609 turns and 0.63 ohm, and shows the effect of inserting different proportions of the total amount of the iron wires constituting the core, which was 7½ inches long.

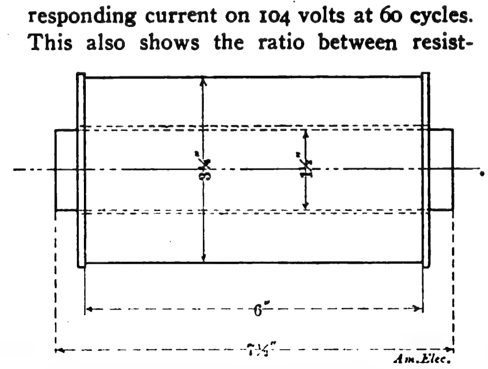


FIG. 3.—DETAILS OF INDUCTANCE COIL WITH TAPS.

The test plotted in Fig. 4 shows that while the resistance in the winding was only 0.63 ohm, the total impedance was 104 ÷ 1.5 = 69.4 ohms, making the resistance of the copper in the winding practically a neglible factor when the 609 turns were in circuit, but the resistance of the copper becomes important when fewer turns are used, as when they are reduced to 131 in this case. This test also shows that the impedance varies approximately as the quare of the number of turns when the resistance is low, and consequently the current varies (approximately) inversely as the square of the number of turns.

In order to prevent eddy currents, the ferric portions of alternating-current electromagnets are made of thin laminae insulated from one another. These should also be very soft so as to keep the hysteresis as low as possible. For this reason alternating-current electromagnet cores are usually operated at lower magnetic densities than direct-current electromagnets. Stampings from transformer iron or steel are suitable for this purpose, and when riveted together make firm frames and armatures. This method of construction naturally makes the cores of squares or rectangular cross-section.

The spools for alternating-current electromagnets are usually made of brass, slotted in the direction of the lines of force in order to prevent induced currents from being established in the brass, which would cause a considerable energy loss as well as overheating the spool and winding.

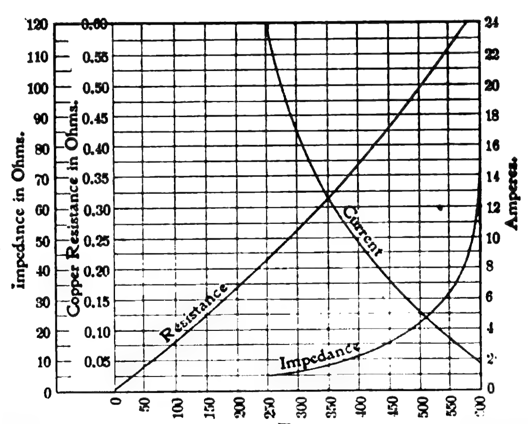


FIG. 4.—CHARACTERISTICS OF INDUCTANCE COIL WITH TAPS.

While the single-coil type of iron-clad solenoid or plunger electromagnet (Fig. 6) presents no serious difficulty in design when punches and dies are made, the two-coil type shown in Fig. 7, made from U-shaped laminations, is more easily constructed, although there are two spools. In this case the armature consists of one of the U's, and the stops are formed by the other. The

rest of the construction is obvious. By mounting shorter spools upon the U-shaped pieces, very good horseshoe electromagnets for alternating-current work are obtained.

Fig. 8 shows the result of a test of the two-coil electromagnet shown in Fig. 7. This test was made with 104 volts at 60 cycles, the spools being connected in multiple across the supply circuit. Each spool contained 1,400 turns of wire. The fact of the current rising tends to keep the curve up, whereas if the current were constant, as

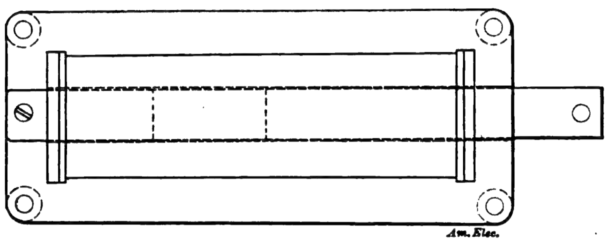


FIG. 6.—SINGLE-COIL TYPE OF ALTERNATING-CURRENT PLUNGER ELECTROMAGNET.

in a direct-current electromagnet, the pull would fall off much sooner near the end of the coil. On the other hand the maximum pull would be much higher if the current were constant, at say 6 amperes. If it were not for the fact that the coils are half full of iron when the plungers are all the way out, the current curve would not bend over as it does in Fig. 8, but would bend upward.

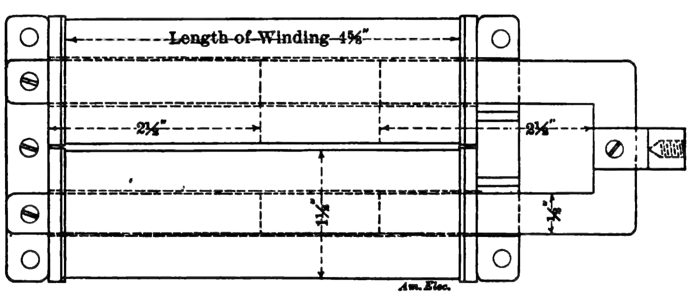


FIG. 7.—TWO-COIL ALTERNATING-CURRENT ELECTROMAGNET.

This magnet is capable of a much stronger pull with correspondingly stronger current, but it was designed for continuous service, and therefore would overheat if the impedance were made lower. This objection may be overcome by switching in an

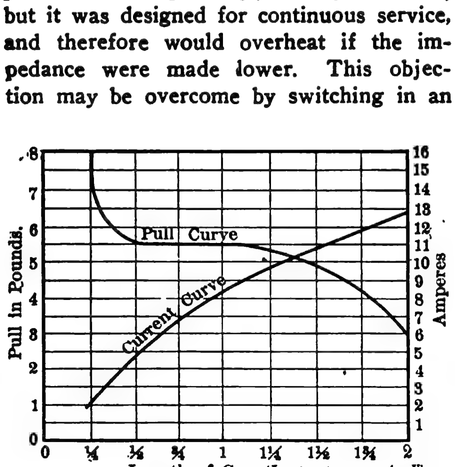


FIG. 8.—CHARACTERISTICS OF ALTERNATING-CURRENT, TWO-COIL, PLUNGER ELECTROMAGNET.

inductive coil at the end of the stroke of the armature, unless the electromagnet is operated too frequently.

For a longer range of action the stops or ends of the stationary U-shaped piece should be shortened so that they would only project a short distance into the winding, say ½ inch in this case. The effect for very long alternating-current iron-clad solenoids is an almost constant pull over a long range, but with an ever-changing strength of current. While the suddent inrush of current at the beginning of the stroke of an alternating-current electromagnet is objectionable in many cases, the small amount of current at the end of the stroke gives it an advantage over direct-current electromagnets where the current is to be left on after the work is completed, and makes the use of an automatic cutout with an inductive coil unnecessary. The alternating-current electromagnet of the type mentioned tends to take only what current it needs for a uniform pull.

Greater care must be exercised in alternating-current than in direct-current windings, for where the short-circuiting of a few turns of wire would do no appreciable harm in a direct-current electromagnet, the result would be disastrous in an alternating-current magnet.

Where the magnet is to be used on circuits of more than one phase, the magnet may be connected in one of the phases only, or magnets corresponding in number to the number of phases may be connected in the respective phases, with their armatures connected to a common bar or lever, as in Fig. 9.

In order to prevent the inrush of current at the beginning of the stroke, an inductive coil may be used as a compensating coil. This should be of comparatively low resistance and of few turns, so that while it would offer a high inductance when considerable current was flowing, the impedance would be small when the current was decreased as the iron plunger entered the coil of the electromagnet. This arrangement, of course, tends to reduce the pull at the start. One disadvantage of the alternating-current electromagnet is the disagreeable humming sound which is produced when the armature approaches the poles. This effect will also be noticed in other parts of the magnet when the laminations are not firmly fastened together.

AN AUTOMATIC BOILER FEED PUMP.

BY HENRY F. SCHMIDT.

It is strange that consulting engineers and designers of power plants have failed to appreciate the advantages and economy of using motor-driven or turbine-driven centrifugal pumps for boiler feeding, for, as will be shown below, they meet every condition perfectly and really present the ideal method of accomplishing this ex-

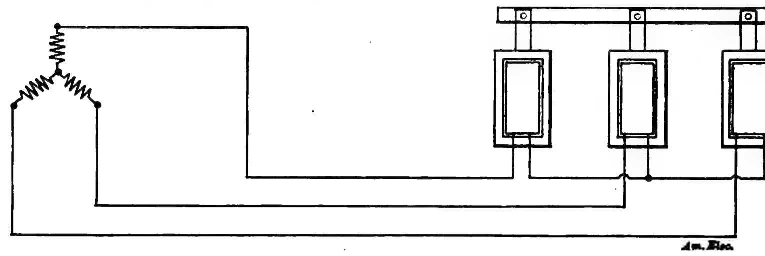


FIG. 9.—METHOD OF CONNECTING ALTERNATING-CURRENT ELECTROMAGNETS TO OPERATE ON THREE-PHASE CIRCUITS.

tremely important work.

The first point in favor of the centrifugal pump is that it has neither suction or discharge valves; the next is that it has but one moving part which has a continuous rotary motion and delivers the water in a constant stream, in contrast with the intermittent impulses of the common duplex pump generally employed for this class of service. The result of the latter feature is that there is no vibration of the pipes, which often causes no little trouble, and as the motion of the water is steady there is much less chance for scale to deposit in the feed pipes. Of course, it is almost unnecessary to point out the advantages accompanying a valveless pump and one in which there are no plungers to be packed, no steam valves to reseat and no pistons to require new rings from time to time.

Another point in favor of the centrifugal pump, and one which is really the most important, is that the pump, running at a constant speed, delivers water at a certain pressure which it cannot exceed by more than five or ten per cent., even though the delivery pipe be completely closed, which condition with a reciprocating pump would probably mean a broken pipe or pump. This characteristic makes it possible, if the boilers are fed by hand, for a fireman to shut off the feed to any boiler or to all of the boilers without having to leave it or them to shut off the pump, which is impracticable in many plants, where the pumps are located in a separate room. Moreover, it makes the automatic feeding of the boilers a very simple matter, as all that is required is a ball float for each boiler, controlling a balanced valve in the feed pipe. This makes it unnecessary to have a connection to the steam line supplying the pump, as the latter runs continuously, whether any of the boilers are being fed or not. This method of automatic feeding makes all the boilers independent of each other; it is not necessary that the water line in all the boilers shall be at the same level, as must be the case with all other types of automatic feeding devices. This

will be appreciated in plants which contain several sizes of boilers, or where some of the boilers are of the vertical type and some of the horizontal type, having their gauge glasses at widely different levels. The method of arranging the proposed automatic system is indicated partially by Fig. 1, which is intended merely to illustrate the principle.

To illustrate the economy incidental to the use of centrifugal pumps, let it be as-

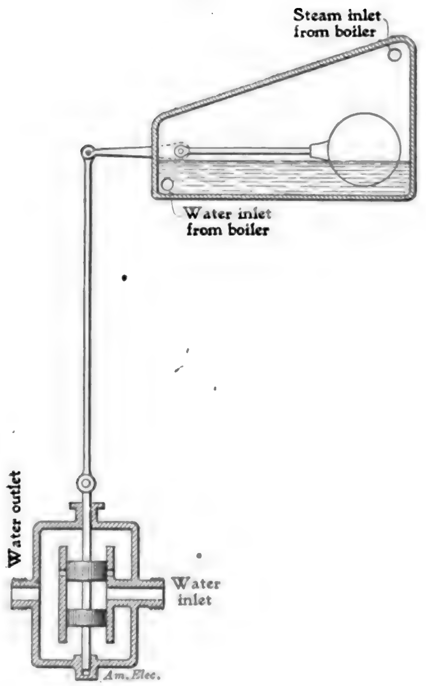


FIG. 1.—AUTOMATIC FEED-WATER SYSTEM.

sumed that the boiler pressure is about 150 lbs. per square inch, that a three-stage, direct-current, motor-driven pump is employed and that the motor receives current from a generator driven by a compound, non-condensing engine of about 200 kilowatts capacity. For this outfit, it is conservative to assume an efficiency of 55 per cent for the pump, 85 per cent for the motor, and a steam consumption of 40 lbs. per kilowatt-hour measured at the switchboard. On this basis the steam consumption of the feed pump would be 64.2 lb. per water horse-power per hour. Now, to favor the reciprocating pump, assume that a compound duplex pump is employed, the steam consumption of which under favorable conditions would not be below 70 lbs. per indicated horse-power and which under favorable circumstances might have an efficiency of 85 per cent. Under these conditions the consumption of steam would be 82.4 lbs. per water horse-power per hour, showing a saving of 18.2 lbs. per hour in favor of the centrifugal pump, though the assumptions made are a little more favorable for the duplex pump than for the centrifugal.

Besides the actual saving in steam obtained by the use of the centrifugal pump, there would be another large saving due to the difference in repairs, since the only parts to wear out on the centrifugal pump are the bearings, which can be renewed at small cost and replaced in a few minutes, while the duplex pump requires new valves and packing for the plungers and demands considerable attention in the way of adjustment and regulating the speed to meet the demand made upon it by the boilers; this attention is not required by the centrifugal pump. Had it been assumed that the plant was run condensing, the saving in favor of the centrifugal pump would have been still greater, for the engine driving the generator would use the vacuum to much greater advantage than the duplex pump.

It might be suggested that the efficiency of the centrifugal pump would be very low when supplying only a small portion of its full capacity, and would consume power when merely churning the water without delivering any, but this objection can be met with the fact that a steam pump causes steam waste even when it is not running, and as its steam consumption is also very much greater at part capacity, it is highly probable that under ordinary working conditions the saving of the centrifugal pump over the duplex pump would be just as great proportionately at part load as at full load.

Furthermore, as the centrifugal pump gives a steadier feed and can be more accurately regulated, the maximum capacity of a centrifugal pump to supply any given battery of boilers would not have to be so great as if a duplex pump were employed; therefore, the centrifugal pump would be operating nearer its point of maximum economy than the duplex pump, and would therefore give a better average efficiency. The centrifugal pump would be somewhat more expensive than the duplex, but the difference would soon be made up by the saving in fuel and in the cost of maintenance and repairs.

Abstracts from Foreign Contemporaries

A Lamp for Temporary Installations.—The London *Electrician* illustrates a new lamp for use on temporary installations, and particularly for illumination purposes. The cap of the lamp is designed to enable it to be connected directly to the cables or wires without the intermediary of a lamp-

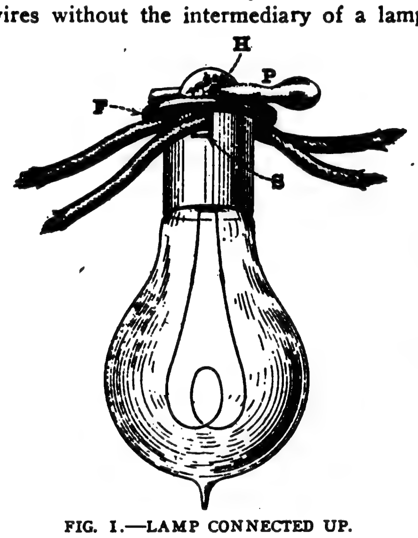


FIG. 1.—LAMP CONNECTED UP.

holder. The lamp cap is of china, and it has two grooves, in which spring contacts, *S S*, are fitted, as shown in Fig. 2. These two springs are separated by a china wall pierced with a hole, *H*. The two conductors are bared sufficiently to make contact with the top of the springs *S S*, and the fiber plate *F* is then passed over the china wall and is held in place by the wooden pin *P*. Fig. 1 shows the lamp connected up.

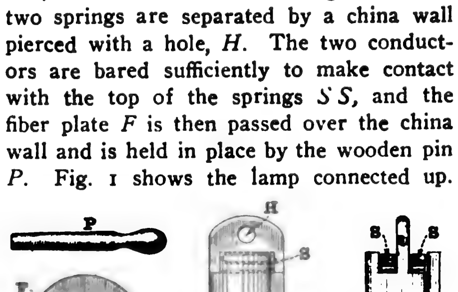


FIG. 2.—DETAILS OF LAMP CAP, FIBRE PLATE AND WOODEN PIN.

If, for temporary illumination purposes, it is desired to align the lamps accurately, thin slips of wood can be slotted to receive the china wall, and the lamp can then be fixed by placing the wooden pin through the hole.

The Aston "Worm Feed" Brush-Holder.—The brush holder illustrated herewith is described in a recent issue of the London *Electrical Review*. The holder shown is of the box type, and is arranged for rigid fixing to the brush pillar. In order to do this the tube of the holder is

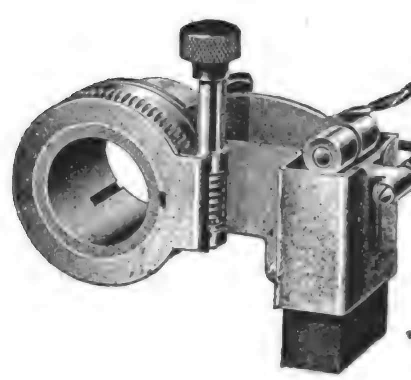


FIG. 3.—ASTON BRUSH HOLDER.

split through half its length, and an encircling clamping ring and key serve for tightening on to the pillar. The carbon brush is pressed down through the holder by two small rollers attached to the end of a lever pivoted on the brush pillar. The worm gear, also centered on the latter, when rotated by means of a thumb screw, exerts through a spring connection the requisite pressure on the lever and brush for the required adjustment. The lever is extended beyond the pressure rollers to provide a ready means of raising it, to try the tension or remove the carbon; its downward movement is confined to a slot, and it cannot touch the commutator. As the thumb screw is provided with an insulated knob, it can be safely adjusted while running.

Ignition Device for Gas and Oil Engines.—The arrangement for igniting and controlling the charge in internal combustion engines shown in Fig. 4 was described recently by the London *Engi-*

neer. The ignition chamber *A* is provided with a thread at its base to enable it to be screwed into the valve box, *B*. The valve seating of the valve *C* is turned in the valve box *B*, which is provided with four bosses; the boss *D* having an internal thread for the closing plug; the boss *E* having an external thread for screwing into the combustion chamber; the boss *F* forming the guide for the valve *C*, and to the outside of which is screwed the extended guide *G*; and the boss at the top into which the ignition chamber *B* is screwed. The port *H* in the valve box is open to the combustion chamber *Z*, and the port *I* to the ignition chamber *A*. *J J* are the vaporizer and air heater, and *K* is the vaporizer jacket. *L* is the engine admission valve; *M* is the half-speed shaft of the engine, to which is fixed the cam *N*. The lever *O*, the upper portion of which is shown broken off, is mounted on the fixed fulcrum pin *P*. The lower arm O_1 of the lever has suspended from it the link *Q*, which has a pin fixed at its lower end, on which are fitted two small rollers *R*, one on each side of the lever, which run on the face of the cam. *S* is the working piston and *T* the cylinder. When the piston returns, compressing the working charge drawn into the combustion chamber *Z* through the valve *L*, the compression pressure in *Z* lifts the valve *C* from its seat against the resistance of the spring C_2, and the chamber *A* fills with working charge. At a certain point in the compression stroke toward the end of it the small charge in the ignition chamber *A* is ignited. The pressure in *A* then becomes greater than that in the working cylinder, and consequently the valve *C* is kept tightly on its seat. On the dead point, or at the required lead before it, the cam *N* comes in contact with the rollers *R* on the suspended rod *Q*, and the latter then opens the valve *C* by pressure on the spindle end C_1. The ignited charge under pressure in the chamber *A* then flows rapidly into the working cylinder and ignites the main charge. The cam *N* continues to hold open the valve during two strokes, the working and exhaust strokes, and permits it to close at the end of the exhaust stroke. The pressure in the chamber *A* thus falls to approximately that in the working cylinder at the end of the exhaust stroke. To vary the time of ignition the lever *O* is shifted either by the governor or by hand.

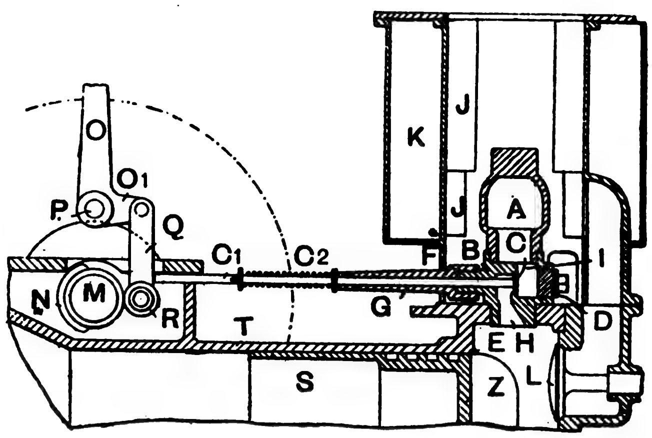


FIG. 4.—IGNITION DEVICE FOR GAS AND OIL ENGINES.

The Cyclone High-Speed Engine.—*Engineering* describes the small high-speed enclosed steam engine illustrated in Fig. 5. These engines have been specially designed to meet the demand for high-speed engines suitable for direct coupling to dynamos, fans, and similar machinery which have to run continuously for long periods without special attention. They are at present built in four sizes, the maximum speed of the three smaller sizes being 600 r.p.m., and of the larger size 450 r.p.m.. As will be seen from the illustration they are designed as compactly as possible consistent with accessibility, and their details follow the best high-speed practice. All parts are machined to jigs and gauges, so that they are interchangeable. The cylinders are tested hydraulically after machining to insure soundness of the casting, and are well lagged all over and clothed with planished steel. Piston valves are fitted, and are ground and lapped to fit the bore of the valve chest. They "float" on the spindles to find their own centres, and are not fitted with rings, except in the larger sizes when desired. The pistons are of forged steel, and the piston rods are accurately ground to size. The crossheads are made solid with the piston rods, and are fitted with adjustable cast-iron slippers turned when in position to the bore of the guides. Metallic packing is used in all stuffing boxes. The crank and eccentrics are cut from the solid, and the shaft is finished all over, the balancing of the rotating parts being done by weights cast in the fly-wheels. A throttling governor driven from the crank shaft maintains the speed with 1½ per cent. at all loads, with a momentary increase not exceeding 5 per cent. when full load is suddenly removed. It can be also regulated by hand when the engine is running. An oil-pump, driven from the eccentric strap, supplies forced lubrication to all moving parts, the crank pin and eccentric being fed through a hole in the crank-shaft from the main bearings, which are the main source of supply. These bearings are adjustable,

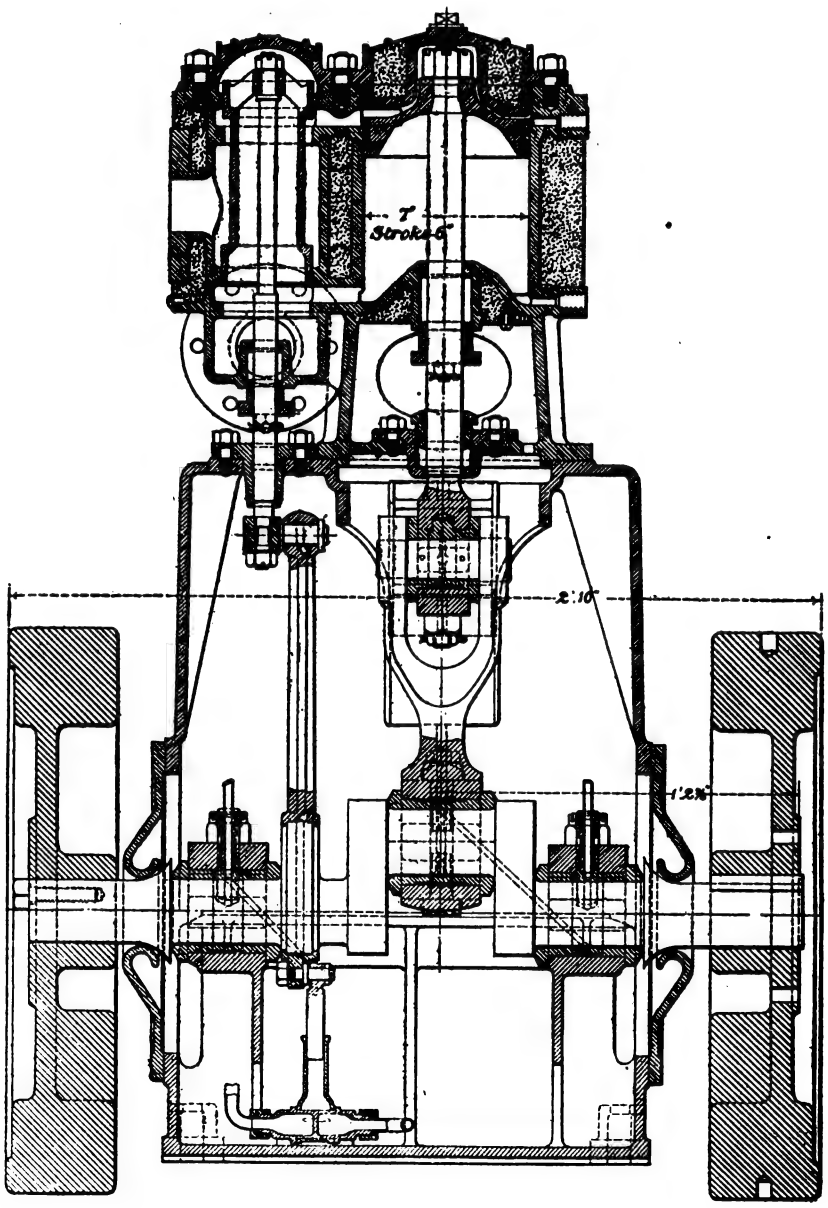


FIG. 5.—CYCLONE HIGH-SPEED ENGINE.

and can be removed and replaced without taking out the crank-shaft. A large door in the front of the casing provides access to the interior, a small door underneath being provided for getting at the oil-strainers, pump, etc. End doors outside the main bearings are moulded so as to prevent the escape of the oil thrown off by the oil-rings on the shaft, and all the interior of the casing is given two coats of a white enamel specially prepared to withstand the solvent action of hot mineral oils.

Modified Form of Schmidt Superheater.—Illustrated herewith is a modified form of the now well-known Schmidt superheater. In this design the superheater is provided with two steam chambers and with tubes closed at the end and having a partition to form two passages for the steam in each tube. The object of the partitions is to prevent the heat from one passage penetrating to the other. Referring to the illustrations, A is the superheater casing, B the cover, and C the tubes closed at one

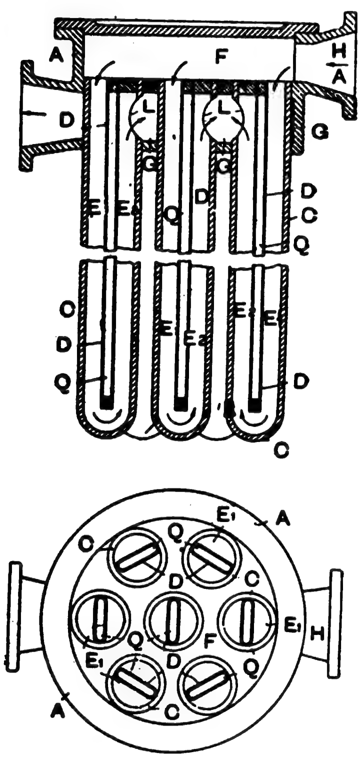


FIG. 6.—MODIFIED SCHMIDT SUPERHEATER.

end. D is a partition within the tube for dividing the interior of the tube into two spaces E_1 and E_2. The partition forms a casing Q and prevents the temperature of the steam passing along the space E_2 from being transferred to the steam passing through the space E_1. The hollow space of the casing Q is filled with heat non-conducting material. The apparatus operates as follows: The steam enters the chamber F through H, passes through the spaces E_1 and E_2 and leaves the tube at L, entering into the second chamber G; when passing the space E_1 the steam is heated by the influence of the burning gases surrounding the tube C and then the steam flows through the passage E_2 where it is further superheated by the influence of the gases surrounding the tube C. By the arrangement of the heat non-conducting partition Q the superheating is not disturbed by the steam passing the space E_1 which is not superheated to the same extent as the steam in the space E_2.

Storage Batteries and Their Electrolyte.—At a recent meeting of the Faraday Society, a paper was submitted by R. W. Vicarey, in which the author gave a résumé of observations and experiments referring to the deleterious effect of nitrogen compounds (especially ammonia) upon the durability, efficiency, and behavior of storage batteries. The paper deals with the action of ammonia and other nitrogen salts, and the salts of potassium, sodium, aluminium, magnesium, and calcium, and it discusses their uses in the various manufacturing processes. It also deals with the waters and acids used for the electrolytes of batteries. It would appear that ammonia must be considered as a dangerous impurity, the total absence of which, however, cannot be absolutely insisted upon. The presence of ammonia in the surroundings or neighborhood of the cell must be carefully guarded against, and the percentage actually present in the cell must be kept as low as possible by the use of waters and acids of the purest quality. The author points out that above certain limits of ammonia little difference is observed in the behavior of cells, but that below that limit much difference occurs. Thus, in experiments upon cells containing proportions of ammonia varying from 10 per cent. to 0.1 per cent. (7,040 to 70.4 grains per gallon), the loss in capacity was 22 to 31 per cent. immediately after the addition of the ammonia, while cells containing less than 0.1 per cent. did not drop in capacity immediately, but varied intermittently from 10 to 15 per cent, finally settling at the end of eight months to a permanent loss of 15 to 22 per cent. From the data given it appears that ammonia is very slow in its action before it makes any appreciable or apparent loss in the capacity of the cells, the average time being about 12 months, dating from the initial charge. The effects of ammonia in its various combinations appear principally in two distinct forms: (1) It causes an excessive disintegration or shedding of active material at the positive (PbO_2) plate; (2) it becomes deposited upon the negative (spongy) plate, and finally closes up the pores of the active material, thereby causing a decrease in the ampere-hour capacity or efficiency varying from 10 to 60 per cent in about 12 months. The use of water taken from the steam boiler and termed "distilled" is mentioned as a dangerous practice that is common in central stations.

Continuous-Feed Lubricator Fitted With Electric Alarm.—In the lubricator shown by Fig. 7, means are provided whereby an alarm is given when the oil vessel is full or empty, and when the lubricant is not passing properly to the part or parts to be lubricated. The arrangement, which is described in the *Mechanical Engineer*, comprises an oil vessel A adapted to contain liquid lubricant, and arranged to be connected with the part to be lubricated. The oil is supplied into the vessel A by a pump which is connected to a pipe C, above which is arranged a cock D, having a discharge pipe E. In the interior of the oil vessel is a float, suitably guided in its rising and falling movements. The guiding arrangement consists of a rod G passing through a hollow bridge piece H. At the upper side the float is connected by a pin I to a lever J, the opposite end of which is coupled to the plug of the cock D on the oil supply pipe C a further lever K being connected to the pin I of the float. This second lever is pivoted at L to a standard M carried by the upper portion of the oil vessel, and is one through which an electrical connection can be made through terminals M_1 and N wired to a battery or other source of electrical energy, in the circuit of which is also arranged an alarm or indicator adapted to act on the closing of the circuit. The second pivoted lever is adapted to complete an electrical connection at either end. For this purpose

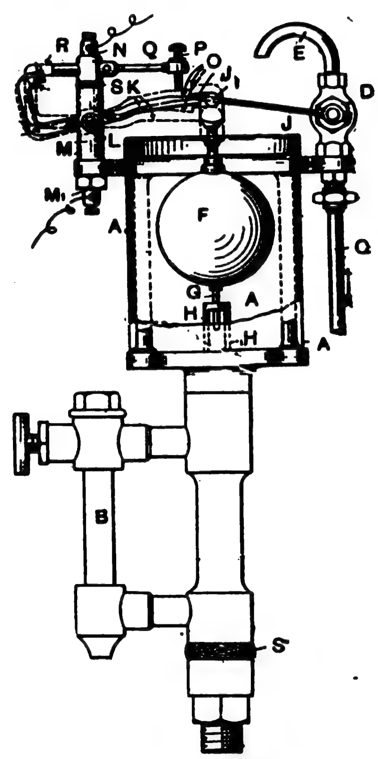


FIG. 7.—LUBRICATOR FITTED WITH ELECTRIC ALARM.

the inner end O of the lever may come into contact with an adjustable screw P carried by an arm Q projecting from the standard M when the oil vessel is full, thereby creating an alarm prior to the vessel overflowing, and at the same time indicating either that the oil supply is in excess of the feed to the part to be lubricated or that the feed pipe is stopped up. Simultaneously the float, by reason of its connection with the cock G, diminishes the oil supply or may be arranged to entirely stop it for the time being. On the other hand, the float may descend and increase the oil supply to the vessel A. In cases where there is not a continuous supply of oil, or, in fact, where such continuous supply is not sufficient for feed purposes, the float may descend and establish electrical connection by the other end R of the pivoted lever K

coming in contact with the standard M, and thereby indicating that the oil in the vessel A is running low. Again, where the feed is continuous the descent of the float may indicate that the oil supply from the pump or other general source of supply is stopped entirely.

Water Meter.—The *Engineer*, of London, describes the Leinert water meter, shown by Fig. 8 herewith. This apparatus is constructed somewhat on the principle of an automatic weigher. The water runs continuously to the meter, but is diverted by an automatic feed alternately to one or the other of two similar tanks. These tanks are balanced on knife edges in such a way that a certain weight of water will tilt the tank and at the same moment transfer the feed to the other tank. Each tank on tilting commences to empty through a syphon and returns empty to its original position in time to again receive water as the companion tank falls and tilts the feeder and

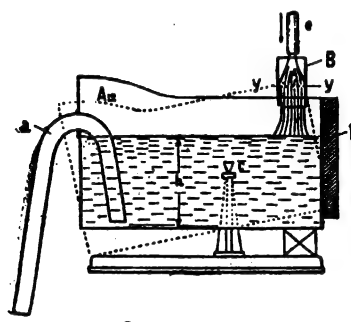


FIG. 8.—WATER METER.

recorder. The water is thereby measured by weight, and not volume, and the meter can thus deal with water of varying temperatures without impairing its accuracy.

Distributing Valve for Steam Engines.—The steam distributing valve shown in the accompanying engravings taken from the *Mechanical Engineer* is specially applicable to feed pumps and other engines adapted to work without the use of a crank shaft and connecting rod. Fig. 10 is a sectional elevation of a steam cylinder provided with the valve; Fig. 11 is a section through the valve box on the line 2—2, Fig. 10; and below is a sectional plan view of the valve box with the top cover removed. The steam cylinder A is provided with passages D and E, through which

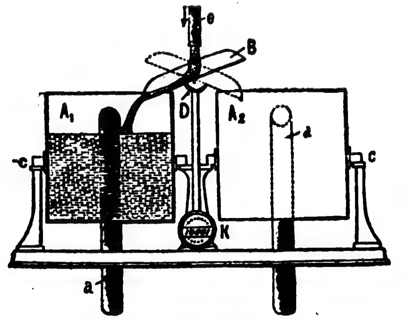
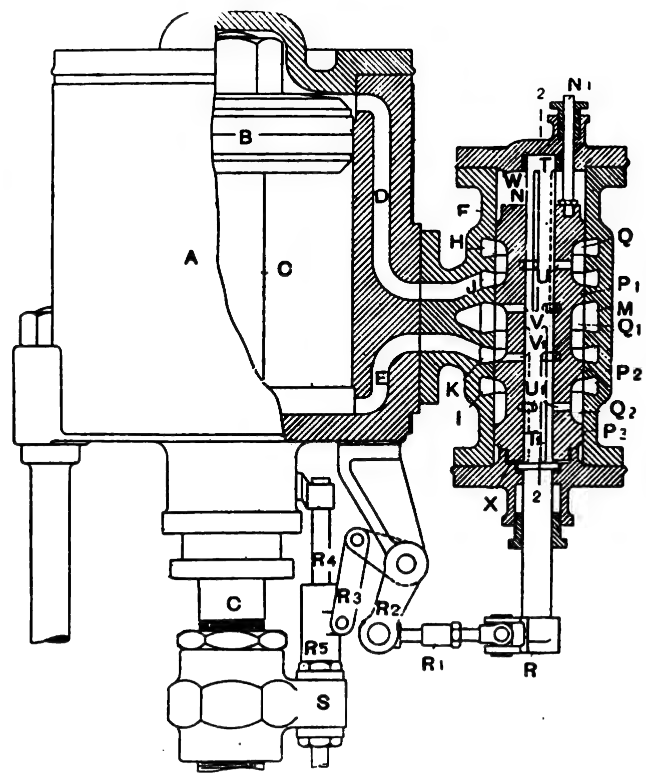


FIG. 9.—WATER METER.

steam is admitted and exhausted alternately. F is the valve box, G being the steam inlet to the valve box, and H and I two annular spaces which are always in communication with the steam inlet G. J and K are annular spaces in the valve box which are always in communication with the passages D and E, and L is the exhaust outlet of the valve box constantly in communication with an annular passage M therein. The valve is made in two parts, which may be called respectively the main C. To enable the auxiliary valve to govern the movement of the main valve grooves T and T_1 are formed along the surface of the auxiliary valve O parallel to its axis. These grooves run the length of the part of the valve within the valve box, with the exception of a plain part in the center. In the two annular spaces Q and Q_2 formed in



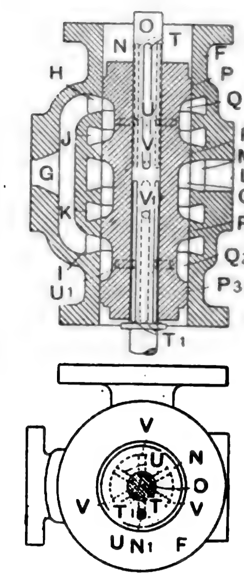


FIG. 10.—DISTRIBUTING VALVE FOR STEAM ENGINES.—FIG. 11.

and auxiliary slide valves. The main valve N performs the operation of distributing the steam to the two ends of the cylinder, and the auxiliary valve O governs the motion of the main valve, which is cylindrical and works in the valve box F. The main valve is prevented from rotating by the rod N_1, and has four cylindrical bearing surfaces. The two inner surfaces P_1 and P_2 serve to cover and uncover the passages J and K, and thereby the ports D and E to the cylinder during working, and so put the ends of the cylinder into communication with steam and exhaust in their proper sequence. The two outer surfaces P and P_3 of the main valve serve as pistons, and the space between them and the cover of the valve box is alternately put in communication with the steam and with the exhaust by the action of the auxiliary valve at the ends of the stroke of the piston, the main valve being thus caused to move from its one extreme position to the other. The auxiliary valve O is in the form of a cylindrical rod which passes through the center of the main valve N, and is rotated about its axis through a suitable angle, at or near the ends of the stroke of the piston, by the motion of the piston rod itself, through the medium of link mechanism. The mechanism comprises the link R_1, bell-crank lever R_2, link R_3, and a tappet rod R_4, to which rod are attached two tappets R_5, only one of which is shown. These tappets R_5 are actuated slightly before the end of each stroke by the striker S attached to the piston the main valve, and which are always in connection with the steam inlet, slots U and U_1 are cut respectively in the valve equal in width to the width of the groove in the auxiliary valve and of convenient length. These slots U and U_1 are so arranged that when those in the upper series, viz., U, are opposite the grooves T in the auxiliary valve, the lower series U_1 are opposite a plain part of the valve, and so are blanked. In the center annular space Q_1 formed between the two inner surfaces P_1 and P_2 of the main valve, which is always connected to the exhaust outlet L, slots or ports V and V_1 are also cut arranged in two rows, and so that if the upper row is opposite a groove in the auxiliary valve the lower row is blanked by the plain surface of the spindle and vice versa. The slots or ports U and U_1 serve to distribute steam to the ends of the main valve alternately, and the slots V and V_1 connect the ends of the main valve to the exhaust port alternately, whereby the main valve is made to move when the auxiliary valve or spindle is rotated about its axis.

Economy in Boiler Plant.—Although builders of boilers are presumably the persons most interested in building an efficient steam-raising plant, it must be remembered, says the London *Electrical Review*, that they are hampered by condition of competition arising from an improper understanding of the process of combustion and heat transmission on the part of prospective pur-

chasers. The paper read before the Institution of Electrical Engineers by Messrs. Booth and Kershaw pointed out that, for the proper combustion of bituminous coal, a large combustion chamber and the use of refractory surfaces is necessary. This, however, means increased cost of boiler setting, and the temptation is very strong to tender for and build a boiler which will generate its guaranteed steam per pound of coal, when, say, anthracite is used, independently of the consideration as to whether other coal can be economically brought to the locality of the boiler. In asking for tenders for boilers, therefore, the class of fuel to be used should be specified and a water evaporation guarantee on this basis asked for. Where such precautions are previously omitted losses in the steam raising plant are certain to ensue. Air will probably be admitted in excess above the grate to avoid smoke nuisance, bringing down the temperature of the furnace gases. Increasing the amount of air admitted increases the energy consumed in producing draft and the amount of heat carried off to the stack. An artifice to prevent the premature cooling of the gases by contact with water-cooled plates and tubes is the introduction into the furnace of refractory brick baffles. Where the combustion chamber is not sufficiently large to contain these refractory surfaces they are often interspersed among the tubes and flues. As, however, the gases have already become partially cooled, such devices can only be regarded as makeshifts to cover an initially bad design, and have, moreover, the effect of reducing the effective draft. Where it is found absolutely necessary for the avoidance of smoke nuisance to admit air above the grates, such air should be previously heated as much as possible to reduce the cooling of the combustion chamber as far as practicable. In some boilers steam is admitted below the fire grate. This device is useful where fuel giving intense local heat, such as anthracite or coke, is used, as the rapid deterioration of the furnace bars is avoided by the cooling action of the steam, and this steam, in passing through the bed of incandescent fuel, unites with the carbon to produce water gas. It is, however, a fallacy to suppose that the admission of steam above the grate aids combustion. The space above the fires should be exclusively reserved for the proper intermixing and ignition of air, oxygen, carbon or carbon-monoxide, and the energy absorbed in the dissociation of water will result in a net loss of heat. To obtain the greatest amount of steam per pound of coal from the boiler the maximum difference of temperature between the water and flue gases must be obtained at every point along the passage of the gases through the boiler. For this reason the hottest water should be found at the point where the gases first impinge on the heating surfaces, and the point of inlet of the feed water should be as near as possible to the point of exit of the gases to the main flue. Due recognition of the elementary principle that cold water is of higher specific gravity than hot will tend to better design from the point of view of circulation, and consequently better evaporating qualities.

CENTRAL STATION ENGINEERS.—XI.

F. W. Little.

The subject of the present sketch was born at Dixon, Ill., on August 26, 1859. He received a common school education and in 1881 removed to Sioux Falls, S. D., where he engaged in the banking business and through the purchase of gas and electric securities had his attention directed to these fields. In 1887 he removed to Sioux City, Iowa, where he continued the banking business and also continued to handle gas, electric, and street railway securities. In 1890 he became president of the Lincoln Street Railway Company of Lincoln, Neb., which company afterwards acquired all the horse-car lines in Lincoln and substituted electricity as the motive power. He remained in this position until 1895. In the fall of this year he migrated to Akron, Ohio, becoming vice-president and general manager of the Akron Gas Co. While at Akron he rebuilt and extended the manufacturing and distribution plant of the Akron Gas Co. In 1899 he removed to Peoria, Ill., where he was offered the position of vice-president and general manager of the Peoria Gas & Electric Company. Since his connection with the company it has acquired all the gas and electric properties in the city of Peoria.

F. W. LITTLE.

Municipal Plant Operation.

To the Editor, American Electrician:

On page 429 of your August number there is a note entitled "'Successful' Municipal Plant Operation," which reflects great discredit on the city lighting plant of this place.

Not to be contentious, I will admit that all you say concerning the conditions at Greenfield are true; but as only a part of the truth is told, the true conditions are grossly misrepresented. In order that a proper conception of the condition existing in the City of Greenfield may be had concerning the municipal control of the lighting plant, the following facts will be of interest: Prior to December 15, 1897, the city was paying $70 per annum per arc lamp for its street lighting—this for midnight service—to provide for the payment of which a special tax levy of 25 cents on $100 was made.

On the above-named date the city purchased the lighting plant from the company then operating it at a cost of $18,400; but as there were no funds in the city treasury to meet the obligation, and as the city's indebtedness at the time was up to the legal limit, eighteen $1,000 notes and one $400 note were given in payment. The city agreed to redeem one of these notes every three months, or, in other words, to pay $4,000 per year on the purchase price. This was approximately what the street lighting had been costing prior to the city's control, and this amount was paid promptly without increasing the tax levy above the original 25 cents, so that in less than five years from the date of purchase the entire plant was paid for. The city is now giving an all-night service and the tax levy has been reduced to 15 cents.

During the seven years that the city has been operating the plant all the original pole lines and overhead work have been reconstructed and during the year 1904 alone approximately 14 miles of wire was used in reconstruction work and extensions.

Since acquiring the plant, the city has purchased one 80-light Brush arc machine and one 200-kw. alternating-current generator; between 300 and 400 wattmeters have been added to the service, together with transformers in proportion to the increase of business. Before the city acquired the lighting plant, commercial users of current were paying from 10 to 16 cents per kilowatt-hour, whereas the rates at present are 7 and 8 cents per kilowatt-hour.

The electrical department of the city of Greenfield has no outstanding debts which are past due; but, on the contrary, has about $3,700 in the fund to its credit. While we are in need of additional equipment, which our surplus is too small to procure, I can assure you that the city's financial embarrassment at the present time is in no wise due to the purchase of the lighting plant; for if the equipment is worth anything to-day—and I believe it is—the city is just that much to the good.

Granting to every man his own views concerning municipal ownership, I ask in justice to our little city that the whole truth be given so that we may be placed right before our neighbors.

E. C. WOLFE.

City Electric Light Plant.
Greenfield, Ind.

The Patent Law Situation.

To the Editor, American Electrician:

For the last 15 years articles have appeared at intervals in the technical press calling attention to the inadequate method of obtaining justice in disputes based upon patents. The last one, by the well-known patent attorney, Mr. Edw. P. Thompson, of New York,* clearly shows some shortcomings of the present method, but he puts matters rather mildly when he says: "As the judge in court is only a legal man, a suit at patent law is nothing more than a burlesque or comedy in the eyes of a technical man."

Many a man who has had the experience of wrong decisions, as well as others who only know about them, charge the judge with being interested or bribed. I, myself, firmly believe in the fairness and strength of character of the judges in American courts, in spite of the many wrong decisions by them and the resulting hardship to many law-abiding citizens; but I wish to point out that the well-known inefficiency of courts in properly dealing with technical cases considerably lowers the prestige of these courts, and may be a direct cause for seeming and actual disregard of laws and ordinances by many.

The concentration of power in large corporations and trusts has also become a feature of the electrical industry, and oppressive methods for removing competition are but natural consequences. Patents are singularly well adapted to further this end, for under the pretext of the desire to enforce laws and rights, suits can be brought which would make manufacturing unprofitable to enterprises of moderate capitalization. Well-planned attacks by attorneys trained for years in such practice, testimony from experts having flexible consciences, and the inexperience of judges in technical matters are three formidable factors for systematically practicing anarchy under the guise of law.

Some ten years ago or more steps were taken by legal profession to overcome the greatest wrongs by presenting a bill before Congress for the creation of a "Court of Patent Appeal." Nothing has been heard of this so far. My inquiry at that time into the probable effectiveness of such an organization resulted in statements which may be summarized somewhat as follows: "It is not all that may be desired, but it is the best we can get at present."

In other words, if a firm has been persecuted for several years and has paid thousands of dollars for legal defence it should be possible to appeal to a court where the subject may be expected to be reasonably well understood and which would enable the weaker party to get justice and not be crushed out of existence. Time has passed for calling attention to facts; action is required by those desiring a remedy from the present state.

Patents are interstate grants and rights and the Federal Government can be appealed to for the desired change. Below is outlined a plan which it is confidently believed will lead to the desired results if every manufacturer of electrical, mechanical or other devices protected by patents, and every inventor, lawyer or other person interested will respond promptly.

It is not believed that a Patent Court of Appeals will give the desired relief and the plan here submitted consists in part in ascertaining from as many representative firms of various industries, lawyers, patent attorneys, judges and inventors, which system may best remedy the existing shortcomings. The plan consists in the execution of the following steps:

1. Everybody interested is requested to examine carefully the various remedies or suggestions submitted at the end of this letter and to select from them the form which he considers best adapted to give the greatest amount of justice at the least expense, or if none of these forms suit, to suggest another way, accompanying the suggestion with a brief explanation. The answer should not be formulated in its final shape before the subject has had four weeks' consideration.

2. The present communication should be shown by inventors, manufacturers and engineers to others, especially manufacturers in other branches, and to patent attorneys and lawyers in their locality, for consideration, judgment and reply in accordance with clause 1.

3. The answers, which shall be considered strictly confidential, are to be addressed to and collected by the editors of the AMERICAN ELECTRICIAN and *Electrical World and Engineer*, such communications to be marked "Patent Law Reform."

4. The correspondence thus collected is to be forwarded to the Bureau of Commerce and Labor, or as suggested by an eminent jurist of St. Louis, if the correspondence is voluminous and representative firms, engineers and attorneys recognize the importance of this matter, a memorial may be prepared and handed, with the communications, by a Congressman or the chairman of the Ways and Means Committee, to the President of the United States, who, according to his judgment, may turn the matter over to the proper department or make suitable recommendations to Congress for its attention and action.

5. In this latter case instructions to Congressmen and Senators by all interested may be desirable, explaining the purpose and results hoped for and asking for their co-operation and support of a bill that will bring about the desired results.

For consideration and selection, the following modifications of the present practice are respectfully submitted in all such legal cases involving patents:

1. A court shall call to his assistance in ruling and deciding in a technical suit an expert uninfluenced by either complainant or defendant.

2. A court shall obtain an expert from the Patent Office selected by the Commissioner of Patents or head of the department in which the patent is classified.

3. A court shall call to his assistance an expert from the Patent Office and another practical or theoretical expert as the case at hand may dictate.

4. A court shall associate with himself a practical and theoretical expert. State or Federal laws to dictate who shall pay for these services.

5. The creation of a lower and upper Patent Office Court as a separate department of the Patent Office. In such a case the complainant informs the lower court that X is infringing his patent No. —— and presents his side; in due course X is notified by the lower court (as at present in a case of interference) to present his case.

a. If considered necessary, lower court official hears cases in different sections of the country at fixed seasons of the year.

b. All matters not involving patents or technical matters to be referred to a local court for decision.

6. Suits involving patents to be handled as heretofore, but all testimony to be sent to Washington for an opinion and assistance from a commissioner, examiner or officer of a department created for this purpose as a separate branch of the Patent Office and manned from the corps of examiners and commissioners of the different departments. Such official to be present at the final hearing of the case and to assist the court in judging the merits of each side.

7. A court of final appeal to be permanently located in Washington and to be formed by the heads of departments or legal lights of the profession.

The opportunity is now open to the individual reader to enter these primaries and give his decisive vote for reform, better patent protection and court ruling. The earnest and vigorous support of everyone interested is desired.

St. Louis, Mo. LUDWIG GUTMANN.

*Electrical World and Engineer, Vol. 45. P. 634.

NOTES.

Automatic Block Signals.—An unfortunate inconsistency appeared in the final installment of Mr. Scott's article last month, on page 423, first paragraph, third column. This should read, "The fact that the initial cost of the installation of the normal danger system is greater than the normal clear system," etc., instead of as printed.

Power Transmission to Stockholm.—It is announced that an agreement has been arrived at between the managers of the Stockholm Gas Works and the Söderfors Bruks A. B. with a view to the purchase of two waterfalls of the Dalelf. These waterfalls, which are situated in the same branch of the Dalelf River, yield about 250 cubic meters per second with a head of 7 meters. With a minimum water supply of 100 cubic meters per second, about 10,000 electrical horse-power would be available in Stockholm, and with 250 cubic meters as much as 25,000 horse-power. The distance is 125 kilometers (about 77.6 miles) from Stockholm.

The Nernst Lamp as a Load Equalizer.—The August number of the little bulletin issued monthly by the Nernst Lamp Com-

pany contains an argument of some merit for the use of Nernst lamps to equalize central station loads, the argument being in brief that by using a very high efficiency lamp it would be practicable to modify the usual two-rate system by charging meter rates during the peak hours and a flat rate during the other hours, the flat rate being presumably graded according to the period of use before and after the peak period.

Portable Telephones.—In order to facilitate the use of telephones, the German Telegraph Department has recently introduced portable telephone instruments in connection with connection boxes, which can be arranged at any desired place, being especially suitable for hotels, restaurants, etc. The connection boxes are fixed to the tables, usually beneath the board; if the customer wishes to use the telephone he has only to ask for the portable outfit which may be fitted immediately to the connection box. An additional fee of only 6 marks per year is charged for each box, while the use of the portable telephone outfit is charged for at the rate of 20 to 30 marks per year. These outfits are used also to allow telephonic communication between vessels anchored in harbors and the telephone system of the harbor town, in which cases the connection boxes are located on the quays and, where necessary, provided with special protective devices.

The Broken Wire. — A correspondent sends us the following simple method of locating breaks in telegraph wires, which he has clipped from a local Pennsylvania paper. The item has only lost the names of the two cities, London and Birmingham, and punctuation marks in its long voyage across the Atlantic; since it was first given to the world by the science editor of London *Tid-Bits* under the heading "When the Telegraph Wire Is Broken." We commend this quasi-scientific and charming effusion to the prayerful consideration of those of our readers who have long struggled with more difficult tests.

> Have you never wondered how when a wire is broken or damaged between two distant cities the operator, sitting in his office, can tell exactly where the accident has occurred?
>
> The explanation is very simple. It requires force to send electricity through a wire. The longer the wire is the greater is the force required. This force is measured, but instead of calling it pounds, as in measuring the pressure in a boiler, electricians call the units of electrical force "ohms."
>
> Suppose a wire between two offices is 150 miles long, and that on a stormy night it gets broken somewhere. The telegraphist knows that when the wire was sound it took just 2,100 ohms to send a current through, or 14 ohms per mile. He now finds that he can send a current with only 700 ohms. He divides 700 by 14, and finds that the break in the wire is fifty miles from his end.

Lectures at the New York Trade School.—Following the usual custom, a series of evening lectures on Steam and Electrical Engineering will be given during the coming fall and winter at the New York Trade School, First Avenue, 67th and 68th Streets, New York. These lectures are intended for practical workers—stationary engineers, firemen, electrical workers and machinists. They present an attempt to satisfy a need for practical information and clear-cut explanation of engineering phenomena and experiences of daily occurrence. The lectures are in the nature of a conversation between the lecturer and his hearers, and questions are freely asked and explanations given, accompanied by illustration and, when possible, experiment. Information as to terms, dates and arrangements can be had on application to H. V. Brill, Superintendent, New York Trade School, 67th Street and First Avenue, New York.

The Utilization of Brown Coal for the Generation of Gas.—At a recent meeting of a German chemical society, Mr. Schott delivered a lecture on this subject. The future utilization of the raw brown coal would have to be looked for by means of gasefication, when the very high percentage of water contained in the coal would be condensed again by the formation of hydrogen in the generator instead of having to be raised to the temperature of incandescence, as in the case of an open fireplace. After cooling, an extremely efficient gas free from any water, which is suitable also for melting purposes, is obtained cheaply. Whereas in the event of its being used for firing under steam boilers, the ratio to common coal is 1 to 3 or 3½, the ratio is only 1 to 2 in the present case. Conditions are as satisfactory in the case of the gasefication of brown coal briquettes when no tarry products liable to interfere with the operation of the generator are obtained, while the fact that more than double the amount of heat energy is stored in the briquettes compensates for the freight charges even for considerable distances.

An Effective Contact Maker.—In branches of electrical work where very sensitive apparatus is employed it is often necessary to make delicate contacts. Especially is this true in physical laboratories and astronomical observatories in connection with accurate clocks and chronometers. It is difficult to make such contacts in the case of a sensitive pendulum, for example, without interfering seriously with its accuracy, and in many laboratories experiments have often been postponed or given up in disgust because of the frictional error involved in making the proper and reliable contacts. In some cases a delicate metal pointer has been attached to the pendulum and allowed to swing through a drop of mercury at the proper time, but this introduces a frictional drag that in some cases is far too great to permit the employment of such a method. A device in use at the Harvard College Observatory in Cambridge, Mass., obviates the friction produced by actual contacts in an ingenious manner. To the bottom of the clock pendulum is hung a small horseshoe permanent magnet. As the pendulum swings over the center of its trajectory the magnet passes directly over a small iron armature mounted on a horizontal spring and attracts the armature toward it without drawing the tiny piece of iron far enough up to make a contact. The air-gap at the moment of maximum attraction is probably not over 1/32 inch wide, but the spring holds the armature back from making an actual contact with the permanent magnet. Attached to the farther end of the spring is a platinum point which makes the electrical contact desired against a fixed platinum stop as the spring moves upward in response to the magnetic impulse. The device works admirably, and the effect of the magnet is simply that of a slight additional mass in the pendulum. The attraction between the magnet and armature lasts effectively but a small fraction of a second, but this is ample for the work of operating the relay contacts.

A New Electrochemical Filter and Purifier—The Edison Electric Illuminating Company, of Boston, has added an electric filter and purifier to the equipment displayed in its Head Place Exhibition rooms. The use of electricity in the laboratory and in domestic work has increased very largely of late, and the purification of water, milk, cider and other beverages is now a matter of widely recognized importance. The new filter, which was made by the Electric Filter Company, of Alliance O., is adapted for almost any class of service, the commercial sizes ranging from 100 to 300 gallons capacity per hour at 90 lbs. pressure. The filter consists of two brass cylinders, tinned on the inside with pure block tin to insure durability and the purity of the product. The smaller cylinder is attached directly to the supply pipe and contains aluminum plates through which the current is passed into the water, forming aluminum hydrate. The aluminum hydrate causes the organic matter to gather in a flaky form of jelly-like consistency, and in case any of the germs escape being killed by the hydrate they are caught in these flakes and together with the water forced through the connecting pipe into the larger chamber, in which is a fine-grained stone through which the water is forced, but which is impervious to the flakes. The enmeshed germs are unable to pass through the stone. In the upper part of the chamber the water is ozonized, which improves its quality. The device is cleaned by taking out the filter stone and scrubbing it with a stiff brush. It consumes about 50 watts or the equivalent of an ordinary 16-c.p. lamp. It is reported that tests made by Dr. F. T. Aschmann, of Pittsburg, on New Castle hydrant water flowing through the purifier at the rate of three pints per minute showed a reduction in bacteria of from 234 to 2 per cubic centimeter, rendering the water practically sterile. Sweet cider treated with the purifier was also rendered nearly sterile, as the innumerable germs in the untreated sample were reduced to 11 per cubic centimeter. The keeping qualities of the cider were also greatly improved, without any impairment of the flavor. In a milk test the bacteria were reduced from 2,891 per cubic centimeter to 27, and Pittsburg water was purified from 360 to 16 bacteria per cubic centimeter.

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CONTENTS.

Centrifugal Pumps for Boiler Feeding.

The merits of the centrifugal pump for boiler feeding are attractively presented in this number by Mr. H. F. Schmidt, who points out that such an application would confer the benefit of automatic feed to a higher degree and with simpler auxiliary apparatus than would be possible with reciprocating pumps. His suggestion for automatic feeding is, broadly, to use a balanced inlet valve on the feed-water pipe of each boiler and a ball float controlling this valve according to the water level; the pump or pumps to be driven at constant speed, of course, since variable speed is out of the question with centrifugal pumps, and it would not be advantageous even if practicable. With such an arrangement the personal attendance would evidently be reduced to the minimum and the water level in each boiler would be independent of the other. Preferably several pumps would be installed so that the pump capacity could be adjusted roughly to the needs of the plant. This naturally leads up to the suggestion of using a number of pumps equal to the number of engines in the station and having capacities proportional to those of the engines, provided the station is of the ordinary simple type. In such a case the number of pumps in operation would always be equal to the number of engines and the capacities would be roughly proportional. Speed regulation not being required, the pumps could be driven by induction motors just as satisfactorily as by direct-current machines, or they might, in small stations, be driven directly by the engines; in the latter case attention to the pumps themselves would obviously be reduced to lubrication.

Besides the reduction in the amount of attention required, both as to adjustment and maintenance, there is a conspicuous reduction in the expense of keeping a centrifugal pump in running condition, there being no packings to renew, no cylinder wear and no valves to grind; the only wearing parts are the bearings, which are simple and inexpensive to replace. It is rather difficult to make a comparison between the steam economy of a centrifugal pump and that of a duplex pump; the efficiency of the former at small loads is pretty low, but with graded active capacity, as suggested in the preceding paragraph, there should be no need to operate at very small loads. Of course, a comparison at full loads is readily drawn, but this does not mean much in actual practice. Such a comparison between duplex steam pumps and motor-driven centrifugal pumps would undoubtedly show up in favor of the latter, and it is possible that even a half-load comparison would not put the centrifugal pump in a bad light. A steam pump, it will be remembered, entails considerable loss in the way of condensation and radiation which is not incurred with a motor-driven pump; but this argument does not apply in a comparison of reciprocating and centrifugal pumps unless one is steam-operated and the other motor-driven.

The Selection of Incandescent Lamps.

The incandescent lamp is probably the most familiar piece of electrical apparatus in existence, and for this very reason the most neglected and abused. To many operating engineers it holds little or no interest as long as it emits a reasonable amount of light; the temptation seldom arises to dust off the bulb, improve the distribution of light by altering the location of the lamp, or to plug a voltmeter into the socket for a few minutes to see if the life of the lamps is being shortened by fluctuations of 4 or 5 per cent above the normal. The purchase of a barrel of lamps is a matter of the lowest bid, for the differences between the various makes seem matters of slight importance in comparison with the problem of the electrical supply bill of the establishment.

As a matter of fact, there is a wide difference in incandescent lamps now on the market, and there is little excuse for a large consumer to buy blindly. First cost is always a consideration, but unless the candle-power, efficiency and useful life are in some way taken into account, money is likely to be wasted somewhere. Few persons outside of the lighting field realize the progress at present being made in the way of improved incandescent lamps. The old efficiencies in the vicinity of 3 watts per candle-power are certainly threatened to be bettered by even smaller sizes of lamps, like the Nernst, the new General Electric 2.5-watt metalized carbon lamp, and the widely heralded 2-watt tantalum filament. It would seem easy enough to give competitive lamps a practical life test before purchasing large quantities, and approximate comparisons of relative light-giving power are not difficult. A covered box arranged in compartments with lamp-blacked sides and a few sheets cleanly printed in small type enable very satisfying ideas of the relative usefulness of different styles of filaments, bulbs and reflectors to be obtained. Many plants cannot afford a delicate photometer, but often recourse can be had to the nearest college or high school physical laboratory with little expense and good results. The point is that there is little

or no economy in mere haphazard buying and that a little scientific testing will often pay for itself in the more lasting satisfaction and efficiency obtained from the better grades of lamp now offered in the market.

Making the Best of the Equipment.

In these days of stopping industrial leaks every progressive power station engineer is anxious to do all that he can to improve the operating efficiency of his plant, but in many cases there seems to be little opportunity to do effective work. The engineer may realize the superior economy of the most modern equipment and may have recommended its purchase and installation, but for unknown reasons the owners do not see their way clear to such action, and the plant limps along month after month with a generating and switchboard outfit that would be a credit to a museum of mechanical and electrical antiquities. Cases like this are by no means fanciful, and from the standpoint of the engineer the situation is often discouraging. Given a lot of belted generators, non-condensing engines, aged piping and leaky pumps that keep the force on the move from Monday morning until Saturday night, there is certainly reason to suppose that efficient operation is out of the question, considering the time spent in simply keeping the bus-bars alive. But as one visits plants in different parts of the country it is impossible to overlook the splendid work which is being done by many engineers under the most trying conditions, with the result that the cost of power per unit of output is actually lower than in the case of better favored installations. It is a source of wonder that a kilowatt-hour can be delivered to the switchboard at such moderate cost in some of these plants where the equipment is so far out of date.

In no sense do we advocate the retention of inefficient and wasteful machinery, but making the most of the means at hand is one of the fundamentals of good engineering. It is the old problem of the man behind the gun once more. A natural mechanic will produce a better piece of work with a jackknife than a poor workman will with the most expensive kit of tools, and an able engineer will likewise often turn old equipment to better account than one endowed with less common sense and power of discrimination can do with the latest products of the manufacturers. Surely there should be no plant in which the piping cannot be kept tight, with insulating covering in good condition; in which the coal cannot be regularly weighed; the output recorded from the switchboard readings; the joints in the wiring kept tight, and the engines thrown into and out of service within their limits of economical operation.

In a recently visited isolated plant supplying a large hotel with heat, light and power, the pumps were located in such a narrow passageway that the high-pressure steam cylinder covering had been barked off by passing employees and supplies; the switchboard lamps and instruments were placed too high above the floor for satisfactory readings; there was a careless burning of incandescent lamps near the windows in broad daylight, and lamp cord was run about without regard to the danger of short circuits and fire resulting from contact with sharp metal surfaces; and finally, the machinery was being operated with practically no regard for the load factor. The plant contained one 45-kw. and two 75-kw. generators, the full-load capacities being 410 and 680 amperes, respectively. The load varied from 300 to 350 amperes, and yet one of the larger units was kept in operation while the small machine was held idle, despite the latter's superior economy at the loads indicated. The engineer confided that the switchboard instruments were seldom read, and yet this was a plant equipped with direct-connected units of modern design, reasonably economical coal-handling arrangements, a well-lighted engine room (barring the switchboard) and good boilers. In the winter season there is, of course, an excuse in many cases for not employing the most efficient steam equipment—compound, engines, high pressures, and possibly superheaters—since the exhaust may all be turned into the heating system, but in the warm season it is certainly worth while to use more care in adapting the equipment to the load characteristics.

Perhaps there is no better way for an engineer handicapped by out-of-date machinery to pave the way toward the purchase of better equipment by his employers than to lay before them each week or month the cost of power per kilowatt-hour. Small improvements can often be made at no great cost to the owners, and if the effect of these steps can be shown in the expense account per unit of output, coupled with an intelligent knowledge of what similar plants are doing with better equipment, the arguments are likely in time to become pretty convincing. Every business man values an analysis on the unit basis; he can grasp the situation almost at a glance where the figures are reduced to conceivable limits. Bring the technical quantities with which the power plant deals down to this unit basis in terms of money per kilowatt-hour, and a long step has been taken toward securing the interested co-operation of the owners.

An Artistic Application of Incandescent Lamps.

The advantages of the incandescent lamp in decorative work of all kinds have been increasingly appreciated of late years, and it is safe to say that the problem in artistic illumination which cannot be solved by the filament lamp is yet to be encountered. From the electric sign in Hebrew characters to the exquisite candelabra of the modern ball room, there seems to be no limit to the flexibility of the incandescent light in meeting exacting and variable conditions.

Some of the best lighting effects thus far produced have been accomplished in picture galleries by installing the lighting units in concealed recesses above the pictures, flooding the latter with a soft, clear illumination that serves to bring out every point of interest without drawing the observer's attention to the sources of light themselves. Except in electric sign work, it is fundamentally important that the lighting equipment shall operate as a means and not as an end. In most displays of pictures the illumination is thrown directly upon the objects exhibited, and this is the case with photographs as well as with paintings. An interesting exception to this practice is found in the superb exhibition of photographic positives at the Harvard College Observatory in Cambridge, Mass. The positives or transparencies displayed are photographs illustrating the observatory's telescopic work, and they are hung in a darkened room, the illumination being supplied by incandescent lamps located behind the plates. The resulting effect is remarkably beautiful, and the flood of soft light which pours through the plates gives the observer a fine impression of how the heavenly bodies appear when viewed directly through a large telescope. Some of the enlarged views are of the moon, milky way, etc., and the details are admirably brought out by the incandescent lamps behind the plates. A comparison of the ordinary method of showing special photographic prints by day or lamp light with the scheme adopted at the Harvard Observatory quickly convinces one of the peculiar value of electrical methods of illumination in solving unusual problems. It is, therefore, well worth while for the progressive central station man to be thoroughly primed upon the artistic as well as the ordinary commercial application of electricity.

AN ADJUSTABLE CONDENSER.

BY CLYDE CHALMERS SWAYNE.

Those who are experimenting with high-potential currents, and especially those interested in wireless telegraphy, will find the condenser herein described to be much superior to either Leyden jars or glass plates. It is easily adjusted, small and compact, and not liable to accidental discharge or breakage. Its construction is simple and inexpensive. The capacity will vary under different surroundings, but is so easily adjusted that this can hardly be called an objection.

Fig. 1 shows a sectional view of the condenser complete. All parts are made of brass, except the top, base and handle, which may be made of wood, but are preferably of fibre or hard rubber.

The base, Fig. 2, is made of 1-in. stock and the top, Fig. 3, of 1/2-in., both being 8 1/2 in. in diameter, with holes bored as shown. The brass plates Figs. 4 and 5, are made of 1/32-in. sheet brass, cut to shape and bored as shown. Ten of the former and nine of the latter are required. The plates of each set should be firmly clamped together and made as nearly alike as possible with the facilities at hand.

In Fig. 6 the spindle, *a*, is turned down from 3/8-in. stock; *b* is 11/16 in. in diameter by 9/32 in. in thickness, drilled and tapped for a 5/16-in. standard thread and then sweated on *a*; *cc* are 3/4-in. standard hexagonal nuts and *d* is a 14-20 nut. The hole *e* should be tapped for an 8/32 thread.

In Fig. 7 *a* is a 3/16-in. rod, 5 9/16 in. long, with a 10-32 thread on each end for the distance shown. The nut, *b*, is sweated on. Four rods with accompanying nuts, together with four 1/32-in. washers for each rod, are required.

One 3/8-in. tube, Fig. 8, is needed, 3 5/8 in. long, with an inside diameter of 3/16 in., to fit snugly over one of the rods, *a* (Fig. 7). Figs. 9, 10 and 11 are distance pieces to hold the discs apart. The bearing, Fig. 12, fits in the center of the base for the spindle to rest in, while the bearing, Fig. 13, is fastened to the top to secure the spindle there. The proper tension on the spindle being secured by the screw, *c*, Fig. 13.

The pointer, Fig. 14, is 4 1/2 in. long. It is bent at one end and filed to a sharp point, the other end being tapped to fit in the hole, *e*, Fig. 6. Two circles 4 in. and 4 1/4 in. in diameter should be drawn on the top of Fig. 3, the space between being divided into degrees, or otherwise as desired.

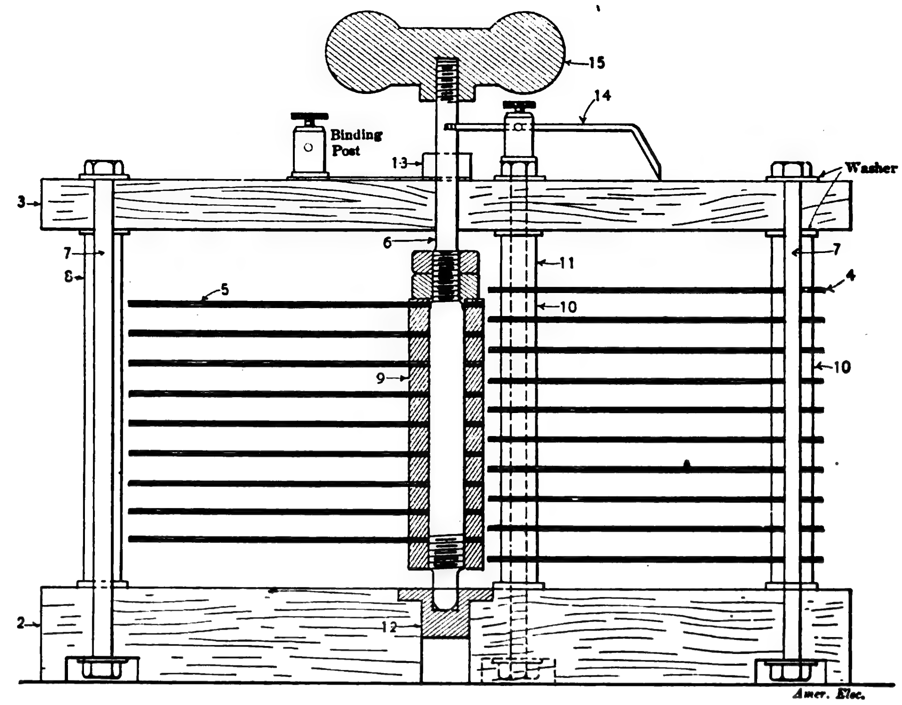


FIG. 1.—COMPLETE SECTIONAL VIEW OF CONDENSER, HALF SIZE.

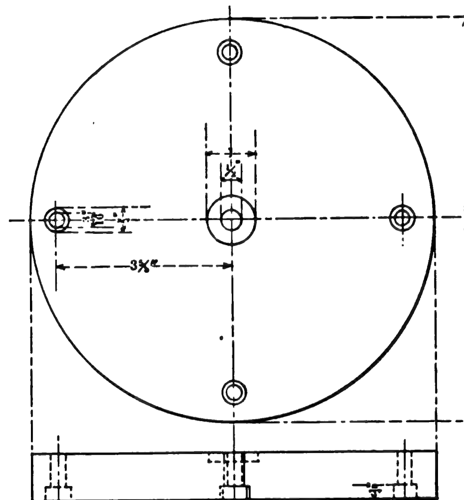


FIG. 2.

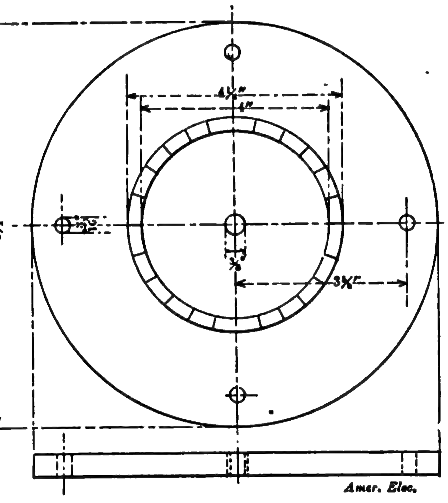


FIG. 3.

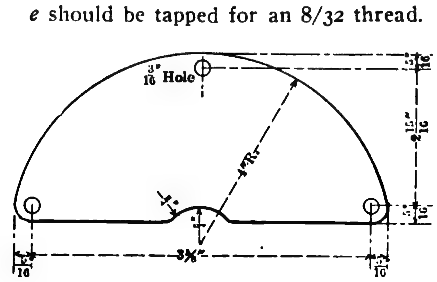


FIG. 4.

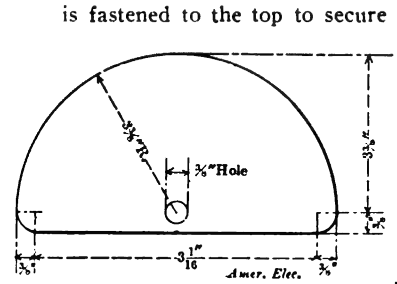


FIG. 5.

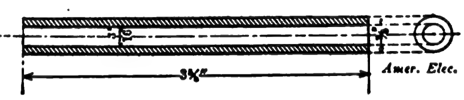
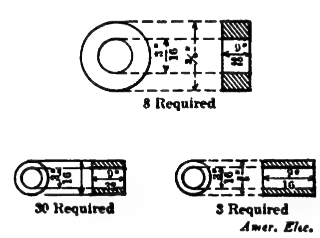


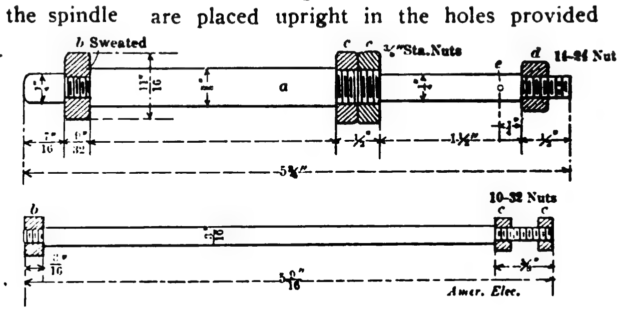
FIG. 8.

Either wood, fibre or hard rubber may be used for the handle. The dimensions given in Fig. 14 are taken from a radiator valve handle. Two binding posts are required; one of these is placed on top of one of the rods, *a* (Fig. 7), as shown in the sectional view, and the other is placed at any convenient place on the top and connected with the bearing (Fig. 13) by a strip of thin copper.



FIGS. 9, 10 AND 11.

In assembling, three of the rods (Fig. 7) are placed upright in the holes provided for them in the base, a washer being placed underneath and one on top. A distance piece (Fig. 10) is then placed on each rod and then one of the larger plates. An-



FIGS. 6 AND 7.

other distance piece is then placed on each rod, then another disc concentric with the first, and so on until the ten plates are in position. Finally, one of the longer dis-

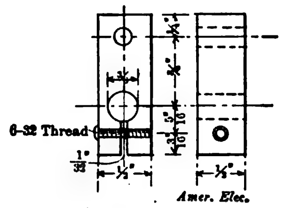


FIG. 13.

tance pieces (Fig. 11) and a washer are placed on each rod. The lower bearing is then fixed in position.

In assembling the smaller or moving plates, the spindle is placed in its bearing and the nut, *b*, adjusted so that its top is just level with the center of the two lower stationary plates. The spindle may then be taken out and the nut sweated on.

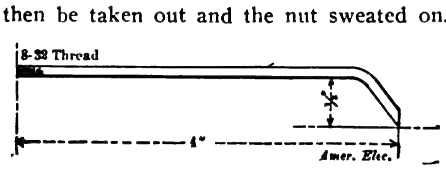


FIG. 14.

When this is done the spindle is replaced and one of the smaller discs slipped on. Then a distance piece (Fig. 9), then another plate, and so on until the nine small plates are in position. The plates should be straightened and placed concentrically with each other. The two binding nuts, *cc*, can be screwed down to hold the plates firmly. The remaining rod can now be put in the fourth hole in the base, with a

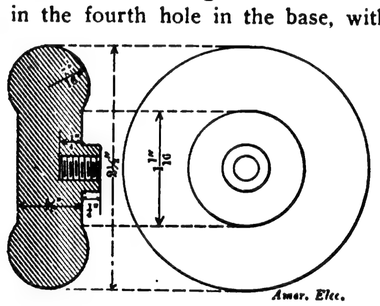


FIG. 15.

washer underneath and one on top, and the tube slipped over it.

Place a washer on each of the rods and then the top may be secured in position by a washer and nut on each rod. The upper bearing can now be slipped over the spindle and secured in position with a wood screw, or if fibre or hard rubber is used an 8-32 machine screw is needed.

The pointer and handle are next put on. The pointer should rest at 180° when the moving plates are entirely outside the stationary ones. A slight turn of the handle is all that is necessary to chance the capacity. Outside the degree circle the approximate capacity can be marked by comparison with a standard. Of course this can only be approximate, as the capacity varies with the surroundings. To make the capacity more uniform, the condenser can be placed in a glass or earthenware jar, with insulating oil around it.

As described, the condenser will vary from about .000626 microfarad when the pointer is at 190°, to about .000126 microfarad when at 360°; i. e., when all the moving plates are inside the stationary discs.

PRACTICAL NOTES ON BOILER-FEEDING APPARATUS.

BY CHARLES L. HUBBARD.

The Injector.

The injector is used extensively in both stationary and marine practice, and exclusively upon locomotives. Its advantages are its compactness and simplicity, having no moving parts when in operation except a light check in certain forms. In stationary work the injector is often used in connection with a pump as a safeguard in case of an accident to the former. The successful operation of an injector depends upon the steam pressure, height of lift, and the temperature of the feed water, and the proper combination of these conditions must be obtained in any case; this makes its field of usefulness somewhat limited. The common form of injector combines two distinct functions, the lifting and the forcing of the water. Fig. 1 shows in diagram the essential parts of the ordinary injector. Steam is admitted through the nozzle *E* and passes through a second nozzle, *F*. The friction between the rapidly moving jet of steam and the air lying between it and the sides of the nozzle *F* causes some of the air to be dragged along, thus producing a reduction of pressure in the chamber, *A*. A partial vacuum being formed in the suction pipe, water is drawn into the injector

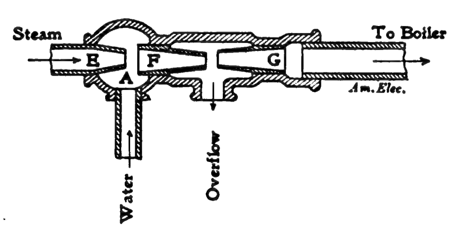


FIG. 1.—INJECTOR.

and thus the first part of its operation is accomplished.

The second part, that is, the forcing action, may be explained as follows: The jet of steam issuing from the steam nozzle, *E*, is condensed by the surrounding water and much reduced in size, while its momentum remains the same. This being the fact, it is able to enter a much smaller opening than that from which it issued, thereby correspondingly increasing the pressure per square inch of section required to stop it. This increase in pressure is so great that the jet not only has sufficient energy to reenter the boiler against its own pressure, but has enough surplus energy to carry in with it a certain amount of feed water. Referring again to the diagram, the steam enters the nozzle, *E*, and flows through the combining or mixing tube, *F*, and is discharged through the overflow. This action soon exhausts the air from the interior of the injector, as already described, and water is drawn up through the suction pipe and discharged through the overflow with the condensed steam. As soon as the water supply has been cut down to the right amount the strength of the jet becomes sufficient to force its way into the boiler through the pipe, *G*. If the injector were made as shown in the diagram there would be a constant dripping from the overflow, because the jet would never be of exactly the right size to enter the tube, *G*, without spattering more or less water from the edges of the opening. This is avoided in practice by making the overflow opening at the top and providing it with a light check valve, which prevents the dripping of water when in use, and yet offers but little resistance when first starting the injector. Injectors of this type are called automatic, because they will re-establish the jet entering the boiler after it has been temporarily interrupted from any cause.

THE REMOVAL OF ASBESTOS FROM ARMATURE LEADS.

BY ARTHUR B. WEEKS.

The accompanying sketch shows an old device with a new application, the device itself having been for years familiar to incandescent wiremen. Its use, especially in connecting sockets in street railway car wiring, is invaluable.

Probably, however, no one has adopted this plan for freeing armature coil leads from asbestos. Naturally, the asbestos is not ordinarily easily removed, and considerable objection has heretofore been raised because of the time and patience required for baring the wire where necessary. With this device it becomes a very simple matter. The tool is grasped firmly with the right

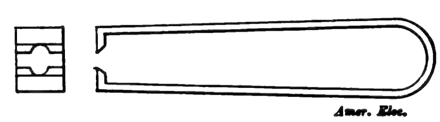


FIG. 1.—TOOL FOR REMOVING ASBESTOS FROM ARMATURE LEADS.

hand and pressed against the wire and with one vigorous pull the insulation may be removed. The tool should not be twisted circumferentially, for if the wire is cut in this way it may break in a short time.

The tool is made of 1/16 in. by ½ in. steel, the cutting edge tempered. If it is a little too stiff the lower portion may be ground down on an emery wheel. The edges should be rounded to make it as easy on the hand as possible.

Asbestos wire is coming more and more into favor for armature and field coils. If plain asbestos wire is used, it is best to dip the coils in a good black insulating paint for the purpose of rendering them moisture-proof and protecting them. Otherwise vibrations might lay the wire bare and cause grounds. Asbestos wire is proof against tremendous heat, and when protected with the proper insulating paint the coil is practically indestructible. The coils should be taped with pure asbestos materials to obtain the best results.

TIME-LIMIT RELAYS.

BY W. T. FERNANDEZ.

Modern practice requires in the installation of large power plants feeding extensive systems of sub-stations, a circuit-breaking device which will automatically open a feeder circuit when serious trouble occurs, but not if this trouble is but of a moment's duration. Various types of relays have been designed to meet the requirements; but it is the purpose of the writer to discuss in the present article only two of the most generally used types with their connections.

The clock type of time-limit relay consists of a clock mechanism which is released by the operation of an armature suspended above a magnet, the latter being energized by current transformers connected to the protected feeder. The time element of the relay is adjusted by shifting the commutator on which the contact brushes bear. This type of relay will not open the circuit on a momentary surge, no matter what its magnitude, unless the duration of the trouble is greater than the time limit set on the relay. Herein lies the disadvantage of this type; since if a relay has been set for 500 amperes with a time limit of two seconds, this limit will be maintained irrespective of the amount of current in the feeder; which, in case of a short-circuit affects the entire system for the length of time for which the relay on the damaged feeder may be set. One brush always bears on the commutator while the other brush only makes contact when either one of the armatures is held down by its respective magnet; thus, if the trouble clears a fraction of a second prior to the expiration of the time limit, one brush is released before the connection bar of the commutator closes the tripping circuit.

The works of this type of relay should be rewound after each release; for since the relay is stopped by a single-toothed wheel actuated by a spring, any defective tension of the stop spring might cause the clock work to entirely unwind after tripping the circuit-breakers, thus rendering the device useless for any additional trouble on the same feeder.

The second type of relay in general use is termed the bellows type, because its action depends on the compression of a bellows by a movable core actuated by a solenoid energized from current transformers connected to the protected feeder. This type of relay has two settings, a minimum and a maximum; the former is controlled by the position of the core with relation to the solenoid and may be adjusted by the threaded knot, *N N*. The minimum setting is usually twice the full load capacity of the apparatus which it protects and the maximum limit is about four times the full load capacity of the apparatus. The high setting prevents the accidental operation of the device, while at the same time preserving its effectiveness in case of real necessity.

The time limit varies directly with the amount of current in the feeder to which the relay is connected as shown in the curve, Fig. 2. It will be noted by reference to the compression line that if the relay is set for 800 amperes with a time limit of two seconds, it will trip the circuit-breakers in 1.6 seconds on the passage of 900 amperes, with a proportionate decrease of time limit as the volume of outgoing current increases. The relay is affected by the heavy lagging currents incidental to a short-circuit on an alternating-current circuit as well as by the effective currents. The apparatus operates instantly under the effects of such a short-circuit, clearing the damaged feeder from the high-tension busbars and the general system in the shortest possible time; so that while this type of relay has all the requirements of a time limit device, it has the additional advantage of becoming instantaneous in its action should the magnitude of the overload on a feeder require such action. Both types of

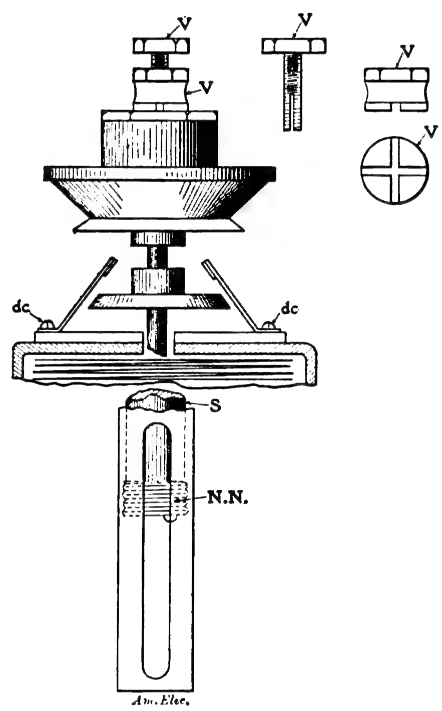


FIG. 1.—BELLOWS TYPE OF TIME-LIMIT RELAY.

instrument require checking and readjusting at regular intervals to insure their proper action. As the operating current of the relay coils is supplied from current transformers connected to the primary leads, it bears a definite ratio to the current in those leads and the test current must be of the same value. For example, if the ratio of the current transformers on a certain feeder be 60 to 1 and the relay is set to operate on the passage of 420 amperes in the primary cables, the current in the relay coils will be 7 amperes, or the primary current divided by the ratio of the current transformer. The test current may be taken from the slip rings of a rotary converter or better still if the machine be six phase, from adjacent lugs of the I. R. T. regulator of a running machine, on account of the lower voltage obtainable from that source. The introduction of a water rheostat, lamp bank or adjustable reactance in the testing circuit, provides a method of control for the testing current.

It is advisable, when possible, to test automatic devices under the exact conditions prevailing in actual service; that is, to time the device from the instant the test current is applied to the time the switch it

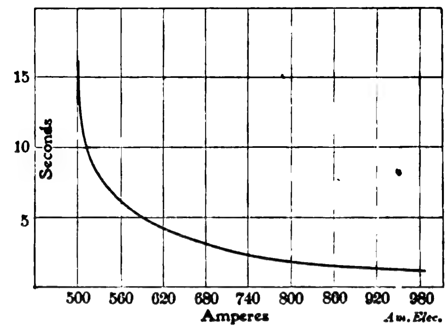


FIG. 2.

is intended to operate opens. If for operating reasons this is impossible, the check and adjustment may be made by disconnecting the tripping circuit from its circuit-breaker and connecting that circuit to a cell of battery with a single stroke bell in circuit with it. The relay is then timed from the starting of its action to the stroke of the bell, as the stroke of the bell indicates the operation of the tripping circuit.

With the clock type of relay, the armature should be held away from the magnet until the current in the coil under test has reached the value required; and then released as a stop watch is released, the watch being stopped at the instant the circuit-breaker opens or the bell rings, depending on the method of checking used.

With the bellows type, the core should be held down until the test current has reached the required value and the time taken from the instant of its release to the opening of the circuit-breaker or the stroke of the bell. When testing a relay the transformers and tripping circuit of the device should also be tested, as a failure of either would render the relay inoperative. Since the transformer wires are usually carried through a double-pole, double-throw switch, which short-circuits the current transformer when closed in one direction and closes the transformer circuit through the relay coil, when thrown in an opposite direction, the testing of the transformers is a simple matter. A pair of test lamps is connected across the center studs in multiple with the relay coil and as the resistance of the lamps is much greater than that of the coil no light will be obtained if the relay coil is closed. If the switch is opened the relay coil is cut out and the lamps are placed directly across the transformer leads and a light is obtained, indicating that the transformer is operative. If the double-pole, double-throw switches are not installed these tests may be made either by disconnecting the necessary wires from the relay after the coil test has been made or by a small coil of wire held against the case of the relay, and connected to a telephone receiver which will indicate the presence of current in the relay coil. It is understood that the feeder, the relay of which is under test for continuity

of coil and transformer wiring, must be carrying some load at the time that the test is made; otherwise there would be no current in the secondary of the current transformers.

The current setting of the clock type instrument is determined by the tension of the springs attached to the free ends of the movable coil armatures; the limiting feature by the distance of the contact bar on the commutator from the brushes. In the bellows type the current setting is made by removing the valves *V V* and adjusting the core, *S*, by means of the threaded nut, *N N*, until the core lifts and trips the switch or circuit-breaker at the required minimum overload—usually from one to one hundred and fifty per cent overload—and after this adjustment has been made the time limiting feature is introduced by adjusting the valves *V V* until the required time limit and overload are obtained.

Once set the bellows type of instrument usually remains reliable; but as a precautionary measure the relays should be tested and adjusted at regular intervals and the tripping circuit every time the apparatus it protects is placed in service. Such a test may be made by connecting a pair of test lamps across the clips *dc* when the switch or circuit-breaker is closed. If a light is obtained it indicates that the circuit is all right, and if no light is obtained an open circuit exists which of course should be repaired before the apparatus protected by that particular relay is placed in service.

Where hand-operated oil switches are supplied with a tripping solenoid connected to a relay, they are usually limited as to the amount of current they may break by a second device termed a limit relay, the function of which is to open the direct-current tripping circuit of the time limit relay, if the volt-amperes, or in other words the short-circuited and incidental lagging currents, exceed the safe breaking capacity of the switch; thus preventing the operation of that relay and throwing the duty of breaking the feeder circuit upon the central station oil switches.

The setting of the limit relay is determined by the known breaking capacity of the switch connected to the time limit relay, the tripping circuit of which is carried through the limit device, and is adjusted by altering the position of the core, by raising or lowering it in its solenoid.

It is advisable to test the bellows for leakage each time the relay is tested, by raising the core as high as possible after the valve, *V*, has been removed, and holding a finger tightly over the valve port; then releasing the core and noting if it drops with any perceptible speed. If so a leak in the bellows may be looked for, and as such a leak will radically alter the time limit, a new bellows should be installed. Defective valves should be replaced with new ones at once and the tripping circuit contacts brightened by crocus cloth each time the apparatus is tested. It is unnecessary to state that absolute cleanliness and absence of dust is essential to the proper operation of overload and time limit devices.

OPEN FEED-WATER HEATERS AND THEIR APPLICATION.

BY W. T. EDWARDS.

It has always been understood that if the condensation of the exhaust steam, with its attendant heat, could be saved and used again, greater economy would result. The great objection, however, to using the condensed steam was the damage caused to the boiler by the cylinder oil entrained with the steam. How to adjust this difficulty has been the subject of much study. It was finally concluded to be next to impossible to remove the cylinder oil from the exhaust; so it was decided to collect as much of the heat as possible without permitting the steam to come into direct contact with the feed-water. As a result, the closed heater was gradually developed.

If the tubes remained clean, or could be kept so with little trouble, the efficiency of the closed heater would always remain the same, but the tubes foul, and become defective from various causes, so that the heater is constantly losing in economy.

By removing the cylinder oil from the exhaust steam, and thus eliminating the possibility of damage to the boiler from that source, it becomes safe to abandon all devices for separating the exhaust steam and feed water and allow them to mix. The loss in efficiency is thus eliminated.

From the foregoing it is evident that, granting the possibility of removing the oil from the exhaust, the superiority of the open type of heater over the closed type is no longer a question.

From the construction of the open heater it is evident that a given quantity of water under ordinary conditions can be heated to a higher temperature with less steam than in the closed heater. Where engines are run condensing the open heater offers an opportunity for driving off the air and g[illegible] from the feed water, which is in itself a favorable point. An opportunity is also given for precipitating and taking out of the water some of the most prevalent and troublesome scale-forming impurities, together with mud and other solid matter. Any means of keeping scale-forming impurities from reaching a boiler should be welcome, as a boiler is a very poor place to purify water. The open heater can be easily cleaned and put back in commission in less than two hours, depending, of course, on the size and condition of the heater; while it is well night impossible to thoroughly clean both sides of the tubes in a closed heater, and any cleaning requires disconnecting the piping with its attendant loss of time.

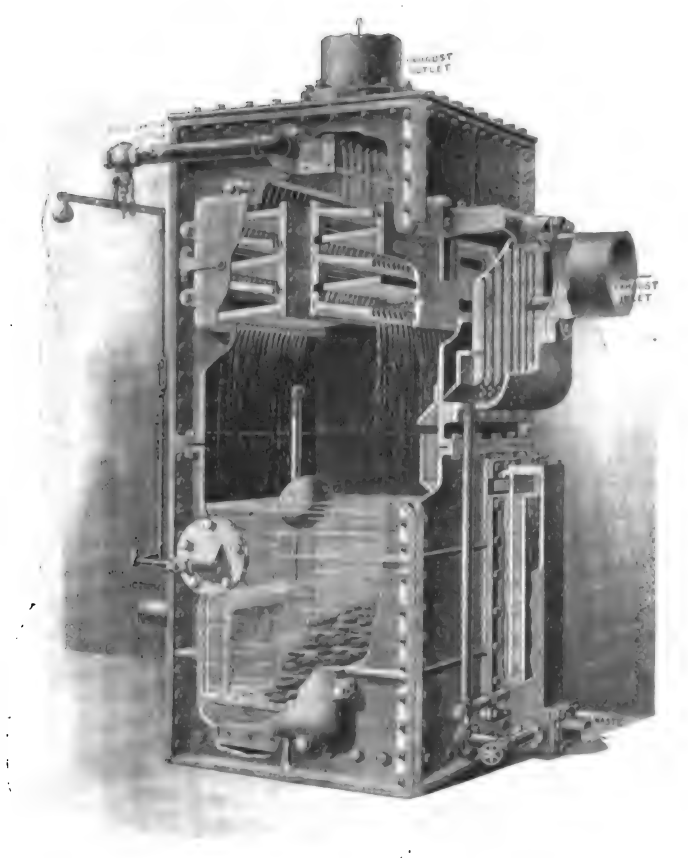


FIG. I.—COCHRANE FEED-WATER HEATER AND PURIFIER.

From a mechanical viewpoint the open heater is preferable because it is under atmospheric pressure, or at most, less than five pounds back pressure, whereas the closed heater is under considerable pressure. Therefore it is not only much easier to keep an open heater free from leaks, but in its construction cast-iron shells may be used, which, together with copper and brass fittings, resist the corrosive action of the air and gases in the water; whereas the wrought-iron or steel shells of the closed heater are very susceptible to this action.

The pumping of hot water is not as difficult as some make it out to be; the secret,

if there be any, is to have the hot water enter the pump with sufficient head to raise the valves from their seats and fill the suction chamber. When that is done and the proper valves used, it is only a question of selecting a pump of the proper size to do the work.

It is only by providing a successful oil

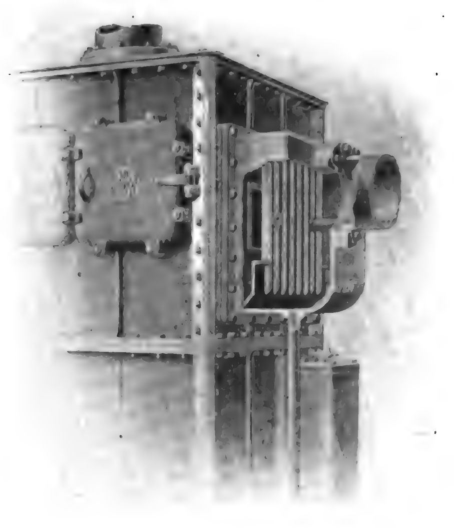


FIG. 2.—DETAIL OF OIL SEPARATOR.

separator that the open feed water heater becomes a possibility.

Among the heaters of this type on the market the Cochrane, manufactured by the Harrison Safety Boiler Works, of Philadelphia, Pa., occupies an enviable position, due to its efficient operation achieved after years of study and experiment. This is due to the oil separator used in connection with it. Fig. 1 shows the heater very clearly. The exhaust enters the exhaust steam inlet and comes in contact with the corrugated baffle plate of the oil separator, which intercepts and collects the oil, the steam passing around the sides of this plate and into the heater, where it mingles with the feed-water. All entrained gases and steam not condensed pass to the atmosphere through the vent pipe or exhaust outlet.

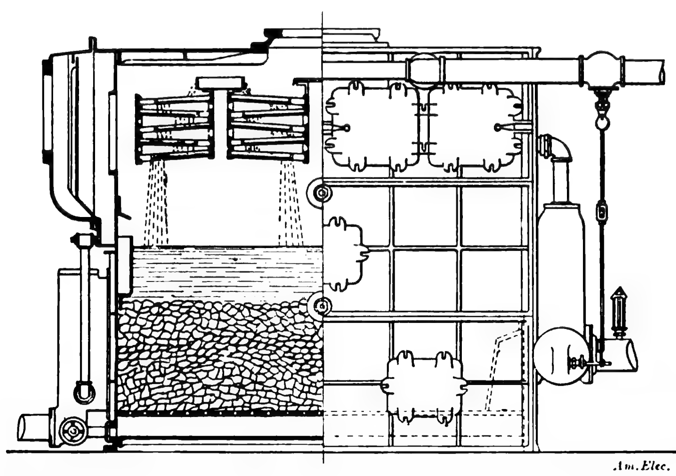


FIG. 5.—HALF SECTION AND FRONT ELEVATION OF OPEN FEED-WATER HEATER, SHOWING TRAY AND CLEAN-OUT DOORS.

The feed-water enters the heater through the cold-water supply pipe and discharges on one set of trays; flowing over the serrated edges in broken spray onto other trays lower down and so on to the bottom, where it passes through a bed of coke supported on a perforated plate, into the pump suction. The cold-water supply is governed by a valve in the supply pipe, which is operated by a ball float.

For removing the oil that collects in the separator, a pipe is connected to it and to a water seal on the waste pipe to the sewer or drain. Connected to this same

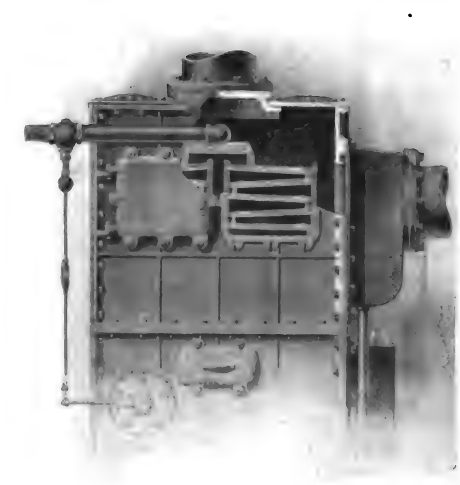


FIG. 3.—REMOVABLE TRAYS AND METHOD OF INTRODUCING COLD WATER.

seal is the blow-off from the bottom of the heater.

Except in the smaller sizes of heaters, which are cast in one piece, each side is formed of one or more cast-iron plates, strongly ribbed, and bolted together at the flanges; all being made steam and water tight with rust joints calked from the inside. Suitable stay tubes and bolts are used in the larger sizes, so that the shells will not be affected by the pulsations of the exhaust steam. The top and bottom plates are also made of cast iron. The oil separator is bolted on the outside of the shell. It is self-cleaning, and is shown in detail by Fig. 2.

The trays, over which the water flows and which form receptacles for the collection of sediment, are placed in the upper part of the shell. They are interchangeable and removable, and the number and arrangement vary according to the size of heater. Each is inclined, and the edges over which the water flows are serrated for the purpose of breaking up the water into spray. The trays are held in place by cast-iron guides, securely bolted to the shell of the heater in such a manner that they cannot be dislodged by pulsations of the exhaust, though they can be readily removed through the cleaning-out doors. Each set of trays is

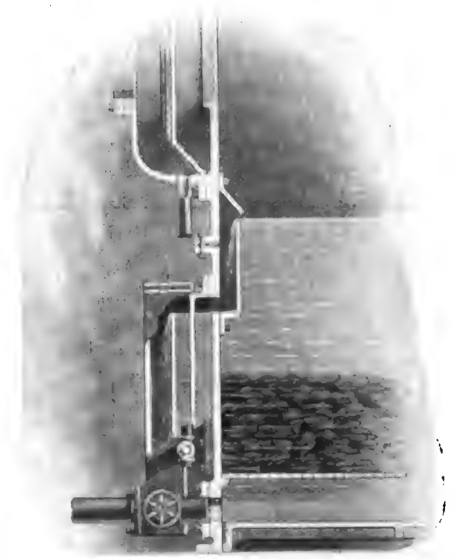


FIG. 4.—WATER TRAP, SKIMMER BOTTOM BLOW-OFF, COKE AND COKE TRAYS.

suspended in the steam space, with ample passages between the supports and the shell for the free movement of the steam. The trays are shown by Fig. 3.

There is a combined skimmer and blow-off, located just above the working level, which extends the width of the heater, for the purpose of flushing off the top layer of water with its lighter, or floating impurities. It is drained through an opening in

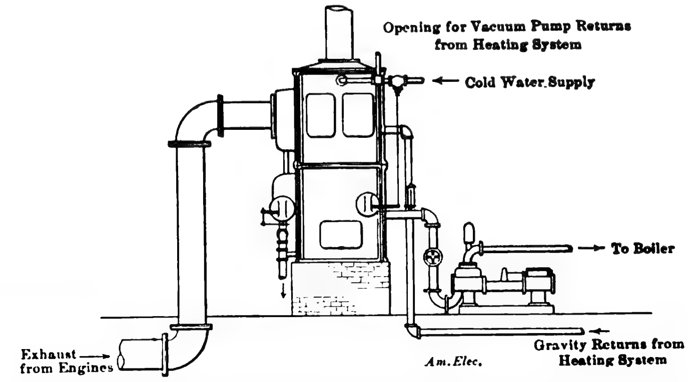


FIG. 6.—SPECIAL HEATER AND RECEIVER PASSING EXHAUST THROUGH HEATER.

the side of the heater into a water seal, as shown in Fig. 4.

The pump outlet is covered by a hood, open only at its lower, or under edge, for the passage of water. This hood extends

below the perforated plate on which the coke bed rests, thus compelling the water to pass through the coke filter before it enters the pump. This can be seen by reference to Fig. 1. The hood is vented by a pipe leading to a point above the working level to prevent air-logging and consequent interference with the flow to the pump, and also to prevent possible syphoning of the water from the heater.

For cleaning the heaters provision has been made to facilitate the operation and to make it possible to clean and examine all parts without disturbing any connections. The faces or joints of all cleaning doors and flanged openings are machined, and standard bolts slipped in slots are used for securing these doors. The tray doors, however, are hinged, so that they may be swung to one side; this is true of all heaters except those the shells of which are cast in one piece. Studs are used to secure the cleaning doors of these heaters. Fig. 5 shows a drawing of one of the heaters and illustrates very clearly the clean-out and tray doors.

When installing an open heater some rules must be observed very closely, while others are not at all important. For instance, it is unimportant where the heater is located with relation to the boiler and engines; but it must be set higher than the pump supplying the water to the boiler by at least two feet. As no pump will lift under pressure and any excess of pressure may injure it. If all of the exhaust steam passes through an oil separator, the drip may be brought down and discharged into the heater, below the water level. If the steam has not been purified the drip should not, under any circumstances, be brought back into the heater, but should be discharged into the sewer.

Conditions under which the open heater may be installed vary, and require different treatment. In some instances all of the exhaust may be passed through the heater, in which case the general arrangement shown by Fig. 6 is applicable. This shows a heater arranged in a heating or drying system; the steam passing through the heater and then into the heating system. As will be seen, the exhaust main is run direct from the engines, pumps, etc., to the steam inlet opening of the oil separator, and from the top of the heater to the atmosphere, both pipes being the full size of the exhaust line. Under no circumstances should any exhaust steam be allowed into the heater before it has been purified of oil. The illustration needs no further explanation, except that attention might be called to the location of the boiler feed-pump.

Fig. 7 shows a heater used to "draw the supply" or used as what is sometimes called an "induction" heater; that is, there is no circulation of steam through the heater, only enough steam being used to raise waste, through the water seal on the heater, if convenient, or through a trap.

The cold water supply may be taken from any convenient source, having head enough to force the water into the heater against the maximum back pressure, or it may be pumped from a well or pond. It is also feasible to use gravity returns, or the water that has been used in the cooling jacket of an air compressor. The gravity returns from a heating system should be water sealed and enter the heater at the regular opening provided for them, unless the returns come back at a comparatively low temperature, in which case they should be entered into the top of the heater and passed over the trays in the regular way. Owing to the cold injection water used in connection with vacuum pumps on heating systems, the tem-

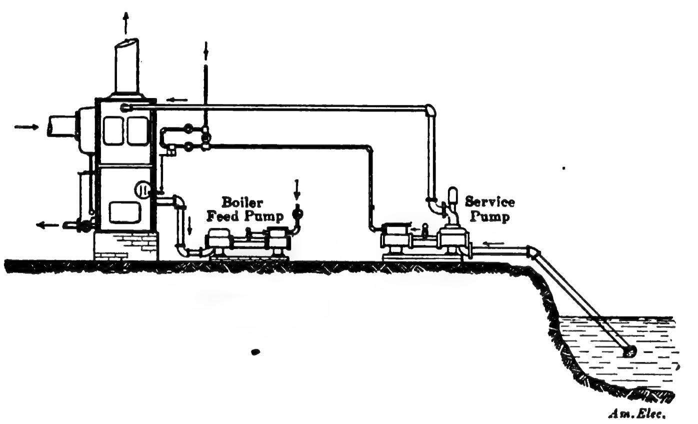


FIG. 8.—HEATER RECEIVING ITS COLD WATER SUPPLY FROM POND OR WELL.

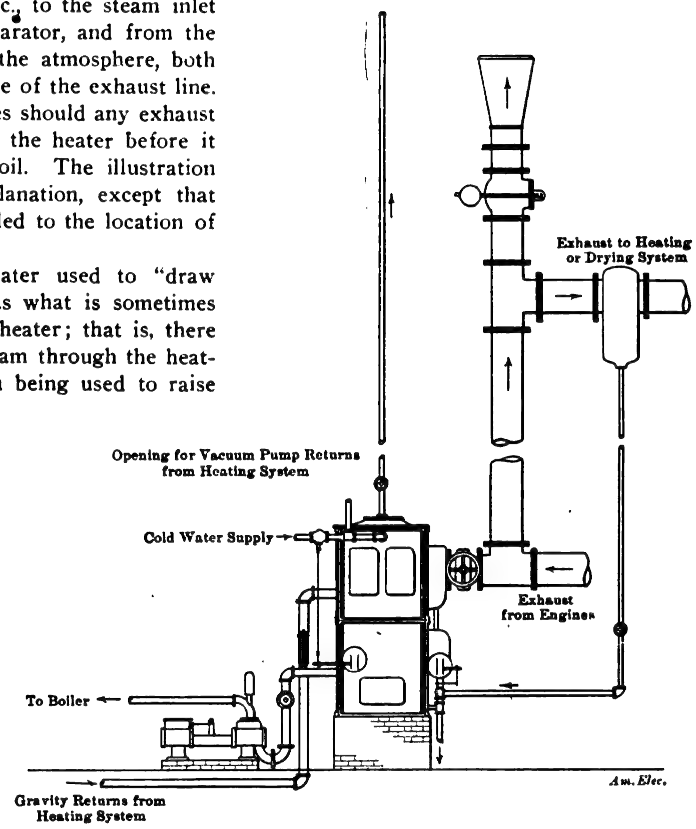


FIG. 7.—SIMPLEST METHOD OF DRAWING THE SUPPLY AND BY-PASSING THE HEATER.

very hot water by suction, there must be head enough to lift the pump-suction valves and keep solid water against the piston; the water must flow into the piston chamber. The pump should be fitted with brass piston rods, metal valves, and the rods and piston fitted with metal packing.

The waste pipe from the trap on the heater is for draining the oil from the separator, the overflow from the heater and the blow-off. It should be of full size and should lead without obstruction to a drain or sewer. The discharge should be lower than the opening in the heater, and no valves of any kind should be placed in this pipe, nor should it be used for any other purpose.

When the heater is under back pressure the valve casing of the back-pressure valve should be drained externally from a point just above the disc, to prevent water from accumulating on the disc and creating excessive back pressure. This is necessary because the heater is not designed to work the temperature of the water to the highest possible point; under such conditions it is necessary to provide a vent connection to allow the escape of gases liberated from the water, otherwise the heater would become air-bound, preventing the steam from entering the heater, and the temperature of the water consequently falls.

The best method of venting is to provide a small pipe from the top of the heater to the atmosphere, carrying this pipe from eight to ten feet higher than the top of the exhaust, and placing a gate valve in this pipe, for the purpose of graduating the area of the vent, opening and closing it until the best results are obtained. The valve is shown on the vent pipe in Fig. 7.

When the heater is installed on the induction system, it is necessary to place an independent oil separator in the branch leading to the heating system, so that the exhaust used for heating will be free from oil. This separator must be trapped to perature of the water delivered to the heater is usually much lower than when returns come back by gravity; therefore it is necessary to pass this water over the trays in the heater, so that it may be heated to the highest possible temperature. An opening is provided for this purpose in the top of the smaller sizes of heater, while in the larger sizes a tee connection is provided in the cold-water supply pipe, between the regulating valve and the opening in the heater. Provision should be made for venting the returns to get rid of the air before the water enters the heater. This may be done by discharging from the vacuum pump into a standpipe or tank open to the atmosphere, and allowing the water to flow into the heater by gravity. The discharge from the tank, or standpipe, to the heater should have a water seal of sufficient depth to prevent the pressure in the heater from blowing the seal.

Where the water is taken from the cool-

ing jacket of an air compressor the connection may be made to the supply pipe, as described for the vacuum pump returns, providing the water from the cooling jacket is less than is required for the heater. If the quantity is more than is required for the boiler feed, a tank or standpipe, as described for the previous case, may be adopted.

The cases where it is necessary to take the water supply from a river or well are rare, but when such a one is found it is customary to use a service pump for delivering the water to the heater. The operation of the pump is governed, and the supply of water regulated by using a balanced valve in the live steam line which is controlled by the float in the heater. This arrangement is shown by Fig. 8. As will be understood this layout is only used where it is impossible to get the water under pressure. The examples cited have had their application only to engines which are run non-condensing; the open heater described is not, however, confined in its usefulness to such plants.

Fig. 9 shows the heater applied to a condensing system, with an oil separator in the main exhaust line. In this illustration is shown a Cochrane horizontal vacuum oil separator with independent tank drainage. The exhaust steam from the condensing engine is passed into the separator through a tapering nozzle piece so as to reduce the velocity of the steam passing through the separator. It is this feature more than any other that has made the separation of oil from steam possible. This oil, together with water removed from the steam by the separator, drains into the tank shown. A vacuum is maintained on this tank equal to the vacuum on the separator by means of an equalizing pipe, thus insuring the complete drainage of the separator. When water accumulates in the tank a float operates a whistle which warns the attendant that the tank should be emptied. By closing the valves in the drip line and equalizing pipe, and opening the discharge from the tank and admitting live steam, the contents of the tank may be quickly discharged, and by reversing these operations the separator and tank are again placed in service.

In a condensing plant the amount of available exhaust steam from the auxiliaries is usually limited so that all the steam is condensed before a temperature of 212° is reached for the feed-water. It is therefore obvious that a heater such as described insures a considerably higher average temperature than when all of the water for the boilers must be heated with the limited amount of exhaust steam, and the condensed exhaust itself wasted through drips.

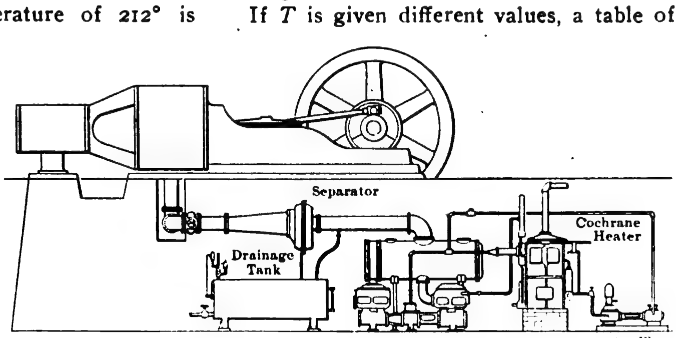


FIG. 9.—ARRANGEMENT OF OIL SEPARATOR AND OPEN HEATER IN CONDENSING PLANT.

It will be noticed in the illustration that the surface condenser discharges into a standpipe, the water flowing into the heater, and the supplementary water being admitted through the regulating valve. It might be mentioned that the drainage tank may be replaced by a good make of return trap. As by the use of these heaters nearly all of the exhaust is returned to the boiler, the economy is obvious, when water must be purchased at, for instance, $1 per 1,000 gallons.

The advantages to be had from the use of the open heater are not alone confined to the larger power stations, but anywhere that steam is generated. They are built in units as small as 50 horse-power and as large as 15,000 horse-power.

A CONVENIENT METER TESTING METHOD.

BY C. A. CORNWALL.

In all meter-testing departments, it is customary to test any meter when returned into stock and find its error percentage. If this error is within certain limits, and the meter is otherwise satisfactory, no further testing is needed, but if, on the other hand, it is found to be running either fast or slow, beyond the allowable limit, it becomes necessary to recalibrate it. The following method of testing meters has been worked out by the writer and found to be entirely satisfactory, giving accurate results and saving an immense amount of time.

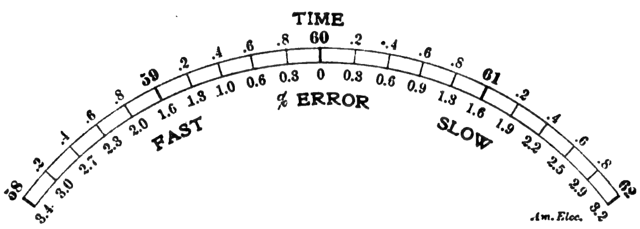


FIG. I.—TIME ERROR SCALE.

The general formula for finding the load which a meter is carrying is $W = \frac{R}{T} \times K$, in which W = load in watts; R = revolutions of the disk; T = time in seconds, and K = calibrating constant of the meter.

If the time, $T = 60$ seconds and W be made such that R will be a whole number in that time (about half load should be used), the actual time, as shown by a stop watch, required by an accuate meter to make. R revolutions will be equal to T in the formula; if this is not the case the percentage of error has to be worked out.

If T is given different values, a table of percentage errors can be worked out for these values, and for all sizes and makes of meters this table will be found correct, provided the proper values of W and R for each case are used.

A time-error scale, made out in a convenient form, is given herewith; also the correct values of W and R for a few meters of different makes and capacities.

Westinghouse Induction Meters.

Type.	Capacity.	Revolutions.	Load in watts.	Constant.
A.	All sizes.	25	half load	1
B.	5 amperes	13	260	1

Thomson Commutator Meter.

Capacity.	Revolutions.	Load in watts.	Constant.
5 amperes	9	270	½
10 "	9	540	1
10 "	18	540	½

Fort Wayne Induction Meter.

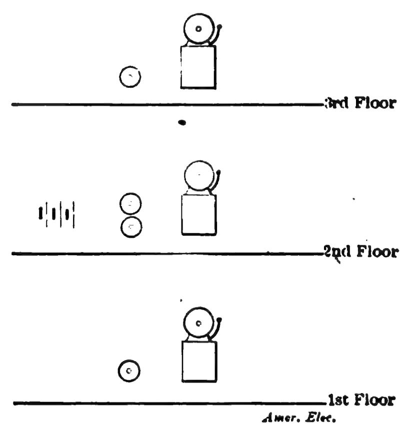
Capacity.	Revolutions.	Load in watts.	Constant.
5 amperes	18	270	1
10 "	18	540	1

Letters on Practical Subjects

Communications intended for publication in this department must be received at this office not later than the 15th of the month prior to the date of publication.

Problem in Bell Wiring.

I have a problem in bell wiring which I would like to submit to your readers for their consideration. A house has three bells, one on each floor. A push button is situated on the first floor, two push buttons and a battery on the second floor, and a push button on the third floor. The problem is to connect the bells in such a manner that the push button on the first floor will ring the bell on the second floor, the push button on the third floor will ring the bell on the second floor, and the push buttons on the second floor will ring the bells on the first and third floors. Not more than three wires can be used in connecting each floor, and there is no communication between the first and third floors.



PROBLEM IN BELL WIRING.

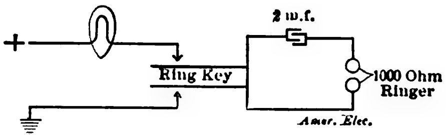
J. H. GAUSE.

Wilmington, Del.

Rise of Potential in Telephone Circuit.

I have experienced a little trouble which may interest your readers. On a pulsating circuit with an e.m.f. of 40 volts at 1,000 pulsations per minute I have connected a polarized ringer (1,000 ohms) through a 2-m.f. condenser and a 200-ohm lamp, as shown in the accompanying sketch. When the current is thrown on the line and the

bell is rung the potential rises to 50 volts, and when the condenser is cut out the potential drops to 26 volts. I would like



RISE OF POTENTIAL IN TELEPHONE CIRCUIT.

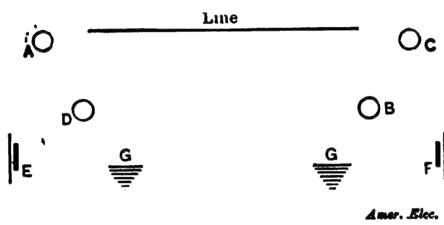
an explanation as to how the extra 10 volts are obtained while the bell is being rung.

N. P. BETHELL.

Washington, D. C.

Problem in Telephone Signaling.

I send herewith a problem which puzzled me some time ago. I found it to be one of the finest bell signaling systems for private line telephones I have ever used, and believing that these problems are as beneficial



PROBLEM IN TELEPHONE SIGNALING.

as any department of your paper, since they furnish information of real practical value to the worker, I submit it to my fellow readers. The problem is to ring the bell at A from the push B and the bell C from the push D and use both batteries E and F at each operation. Only one line wire and a ground return can be used.

W. H. RIGGS.

Everett, Wash.

Problem in Telephone Lamp Connections.

I desire to submit the following problem: Connect the two lamps and the two transfer jacks shown in Fig. 1, so that with a plug inserted in either jack both lamps will be lighted and with both plugs in or out the lamps will be extinguished. I have this transfer in operation here and expect it will be of some interest to your telephone readers.

C. H. FREDERICK.

Zion City, Ill.

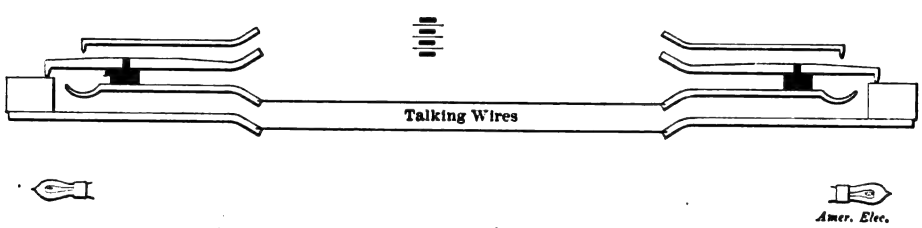


FIG. 1.—PROBLEM IN TELEPHONE LAMP CONNECTIONS.

Mr. Merrill's Bell Connections.

The accompanying diagram is offered as a solution of Mr. Merrill's problem in bell circuits published in the July number. The diagram shows a parallel wired system involving the use of two 2-point and two 3-point push buttons. By pressing the button P, drop No. 1 will fall and bells A, B and C will ring. By pressing button X, bells A and B will ring. Pressing button Y causes

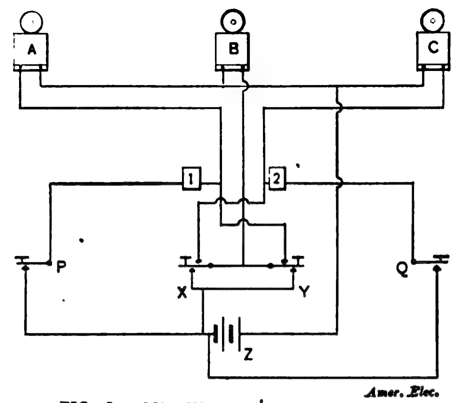


FIG. 1.—MR. WILCOX'S SOLUTION.

the bells B and C to ring, and by pressing the button Q drop No. 2 will fall and bells A, B and C will ring.

E. A. WILCOX.

Scottdale, Pa.

[The foregoing solution was omitted last month by mistake.—EDITOR.]

Mr. Brode's Problem in Mechanics.

The question in mechanics by Mr. Brode in the August number lends itself very readily to a practical solution. Representing the reactions at the supports by R_1 and R_2, it is obvious that $R_1 + R_2 = W$, or the total weight of the beam. Being of uniform weight, the lever arm of each section may be taken at the center of gravity of each section, which in this case will be one-

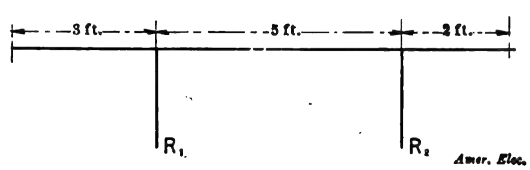


FIG. 1.—MR. VON DANNENBERG'S SOLUTION.

half the length of the section. With R_2 as a fulcrum,

$$R_1 \times 5 = (8 \times 4) - (2 \times 1),$$

whence $5 R_1 = 32 - 2$, or $R_1 = 6$;

with R_1 as fulcrum:

$$R_2 \times 5 = (7 \times 3.5) - (3 \times 1.5),$$

whence $5 R_2 = 24.5 - 4.5$, or $R_2 = 4$.

C. O. VON DANNENBERG.

Schenectady, N. Y.

The following is a solution of Mr. Brode's problem in mechanics. The weight, 10 pounds, acts at the center of gravity, which in this case is at the center of the plank. The reactions at the two supports

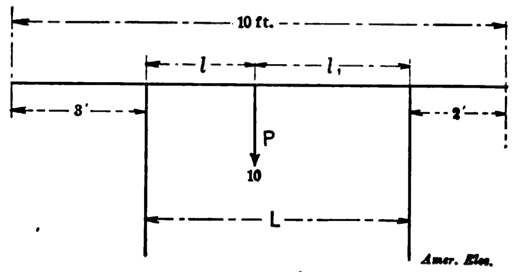


FIG. 2.—MR. ROMINGUEZ'S SOLUTION.

are determined from the following equations:

$$R_1 : P :: l_1 : L,$$

and

$$R_2 : P :: l : L,$$

so that $R_1 = P l_1 \div L$, or $(10 \times 3) \div 5 = 6$ lb., and $R_2 = P \times l \div L$, or $(10 \times 2) \div 5 = 4$ lb.

MANUEL ROMINGUEZ.

Guanajuato, Mexico.

Mr. Brode's problem in mechanics may be solved as follows:

Let x = weight upon the left-hand support; then $10 - x$ = weight upon the right-hand support. Taking moments about the center of gravity and making them equal to each other, as they must be to produce equilibrium, we have $2x = 3(10 - x) = 5x = 30$, or $x = 6$, the weight on the left-hand support. Since the entire weight is 10 pounds, the weight supported by the right-hand support must be the difference between 10 and 6, or 4 lb.

Athens, Ohio. A. A. ATKINSON.

I think the accompanying solution is correct for Mr. Brode's problem published last month:

$$3 : 2 :: x : y,$$

whence $2x = 3y$, or $2x - 3y = 0$.

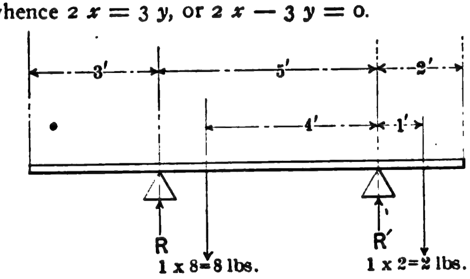


FIG. 3.—MR. BURTON'S SOLUTION.

Since $x + y = 10$, combining the equations we have

$$2x - 3y + 0$$
$$2x + 2y = 20$$
$$- 5y = - 20,$$

whence $y = 4$ and $x = 10 - 4$, or 6.

Greensburg, Pa. R. B. LONG.

[This solution was also received from H. A. Fiske, Georgiaville, R. I.—EDITOR.]

Mr. Brode's problem in mechanics in the August issue may be solved readily by application of the well-known principle of moments of forces. Let R equal reaction of the left support and R' equal reaction of

the right support. Taking moments about the right support in Fig. 3, we have

$$(R \times 5') \div (2 \times 1') = (8 \times 4').$$

From which

$$R = (32 - 2) \div 5 = 6 \text{ lb.}$$

Taking moments about the left support in Fig. 4, we have

$$(7 \times 3.5) = (R' \times 5) \div (3 \times 1.5),$$

whence

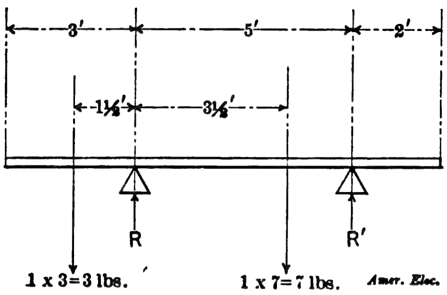


FIG. 4.—MR. BURTON'S SOLUTION.

$$R' = (24.5 - 4.5) \div 5 = 4 \text{ lb.}$$

The left support, therefore, sustains a pressure of six pounds and the right support four pounds.

Baltimore, Md. FRANK B. BURTON.

[A somewhat similar solution to the above was received from J. O. Villars, Williamson, Pa.—EDITOR.]

In Mr. Brode's problem in mechanics the weight may be regarded as located at the center of gravity of the plank. Representing the weight on the support A by the letter x, the following equation is true from the principle of moments:

$$5\,x = 30,$$

whence $x = 6$.

The weight on A being 6 lb., the weight supported by B must be 4 lb.

Oakland, Cal. H. F. MUNSON.

Mr. Brode's problem in the August number may be easily solved by inspection, although the process of reasoning used is not applicable to all cases. The plank being of uniform weight, the 3 feet will balance 3 feet on the other side of the support, and the 2 feet will balance 2 feet, so that if the board were cut 6 feet from the left end both pieces would balance. The weight on the supports would obviously be 6 pounds, and 4 pounds, respectively.

Brooklyn, N. Y. J. T. COE.

[This solution was also supplied by C. O. von Dannenberg, Schenectady, N. Y., and A. A. Atkinson, Athens, Ohio, and is identical with Mr. Brode's own solution.—EDITOR.]

In answer to Mr. Brode's problem I beg to submit the following solution. For all practical purposes it will be correct enough to assume the beam to be without weight and equivalent concentrated loads situated at the center of gravity of each section, as per sketch. Lay off 1—2 = 3 pounds, 2—3 = 5 pounds and 3—4 = 2 pounds. Select any point, as P, and construct the force polygon by drawing the lines 1—P, 2—P, 3—P and 4—P. In a vertical through the first weight, 3 pounds, select a point, as a, and draw a—b parallel to 1—P, projecting it on the support R at b. Draw a—c parallel to 2—P, c—e parallel to 3—P, and d—e parallel to 4—P, projecting to a point in the support R_1. Join b and d and draw the dotted line in the force polygon, parallel to b—d. This intersects the line 1—4, dividing it into two parts proportional to the reactions of the supports, and, measuring it

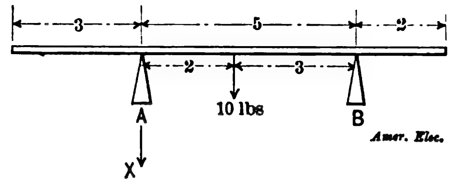


FIG. 5.—MR. MUNSON'S SOLUTION.

according to the scale used, $R = 6$ pounds and $R_1 = 4$ pounds.

York, Pa. CARL E. FREEMAN.

[A similar solution was also received from J. O. Villars, Williamson, Pa.—EDITOR.]

In answer to Mr. Brode's problem in mechanics, I beg to submit the following solution: Consider the pressure at A and B resisted by a force of A and B pounds, respectively, acting upward as indicated. Make three divisions of the plank three feet, five feet and two feet. Now the downward force on the three-foot section is three pounds, and acts as if concentrated at the geometric center, i. e., one and one-half feet from A. The forces and position of

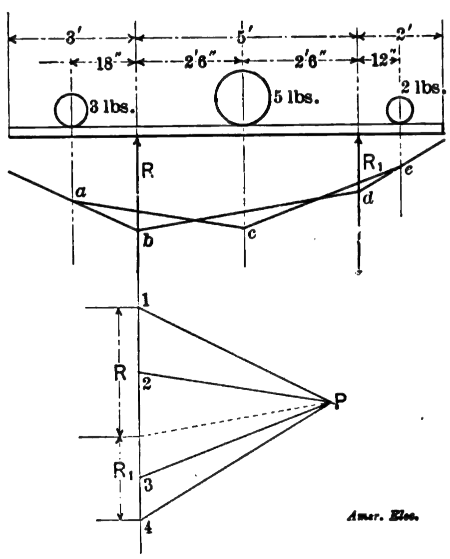


FIG. 6.—MR. FREEMAN'S SOLUTION.

the sections are as shown. The weight on the two supports is ten pounds. There are three forces acting downward which must be equal to the upward forces if the body is at rest. Hence,

$$A + B = 3 + 5 + 2 = 10.$$

Since there is a pressure upward at B, the moment due to the force B about A is $5\,B$, the moment due to C is 3×1.5. The body would revolve and fall to the left of A if the moments due to D (equal to $5 \times 2\frac{1}{2}$), and E (equal to 2×6), did not equal the moments in the other direction. Hence,

$$4\tfrac{1}{2} + 5\,B = 12\tfrac{1}{2} + 12,$$

whence $B = 4$ pounds.

Since $A + B = 10$,

$A = 6$ pounds.

Chicago, Ill. L. W. DUNCAN.

Enclosed find a solution for Mr. Brode's problem in mechanics in the August number of the AMERICAN ELECTRICIAN. Let the line $A - B$ represent the plank which is sup-

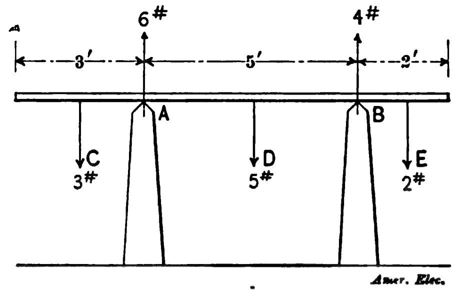


FIG. 7.—MR. DUNCAN'S SOLUTION.

ported at C and D. Since the plank is symmetrical, i. e., of uniform weight per unit length, all the weight may be considered as concentrated at G, the middle point. Substituting forces for the supports as in Fig. 8 and rotating the beam about A, making the summation of all the force clockwise

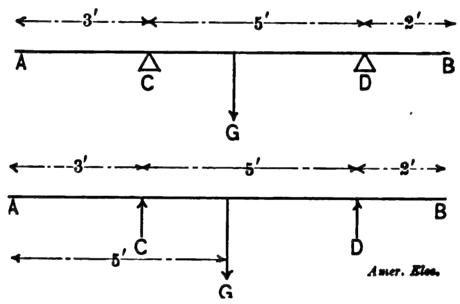


FIG. 8.—MR. CUMMING'S SOLUTION.

equal the summation of all the forces counter clockwise because the beam is in equilibrium, we obtain

$$5\,G - 3\,C - 8\,D = 0.$$

Revolving about C gives

$$5\,G - 2\,D - 7\,C = 0.$$

The summation of the vertical forces $= 0$ gives, using upwards as positive,

$$-G + C + D = 0.$$

This gives three simultaneous equations of the first degree, from which is obtained by simple algebra,

$$D = 4 \text{ and } C = 6.$$

Devil's Lake, N. Dak. F. J. CUMMING.

Enclosed herewith is my solution of Mr. Brode's problem in mechanics. Taking moments of the forces about the point F_1, in

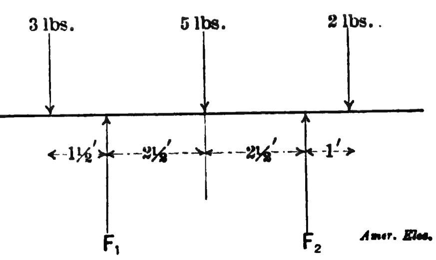


FIG. 9.—MR. SWEETNAM'S SOLUTION.

Fig. 9, we find the reaction, F_2, from the equation

$$(3 \times 1.5) - (5 \times 2.5) + (F_2 \times 5) - (2 \times 6) = 0,$$

$$5\,F_2 = 20,$$

$$F_2 = 4,$$

whence $F_1 = 6$,

Elkhart, Ind. A. H. SWEETNAM.

Questions and Answers

Inquiries not accompanied by the name and address of the inquirer, will not receive attention.

Where can I buy armature punches for small direct-current motors? J. I. H.

From Wilson & Smith, 44 Vine Street, Worcester, Mass.

Why does a three-phase induction motor change its direction of rotation if any two leads are transposed? E. P. C.

Because the direction of the rotating field is reversed owing to the transposition of the two stator circuits.

What is the formula for converting copper wire cross-section from metric measure to circular mils and *vice versa?* G. W.

The diameter in mils is equal to the diameter in millimeters multiplied by 39.37. The diameter in millimeters is equal to the diameter in mils multiplied by 0.02539. Having found the diameter, it is easy to deduce the area in the units in which you are working.

How can I control the speed of an alternating-current motor driving a dental lathe, so as to obtain 1600 r.p.m., 2000 r.p.m., and the present speed of 3400 r.p.m.? The circuit is 104 volts and 60 cycles. W. G. H.

If the motor is of the commutator variety with the field winding connected in series with the armature, it is only necessary to connect resistance in series with the machine in order to control its speed. If it is an induction motor it will have to be sent to the manufacturers to have the speed control applied.

If a motor be coupled to a dynamo of the same voltage and brought up to speed by current from an outside source; and if the dynamo be adjusted to produce the voltage required by the motor and the latter be switched from the outside source to its own dynamo, will the machines continue to run, the dynamo supplying the current for the motor and the latter driving the dynamo? S. K.

Certainly not. Even if there were no internal loss in the windings of the two machines the friction in the bearings would prevent them from running without power from an external source; the internal losses make it still worse.

Is it necessary to ground the neutral wire of a three-wire system? (2) What is the advantage of the neutral ground? (3) Should the conduit of a conduit wiring installation be grounded? W. H. H.

It is not necessary, but the Underwriters recommend it. (2) The maximum e.m.f. to which a person may be subjected while standing on the ground or any grounded metallic structure is limited to the voltage between the neutral wire and one of the outside wires, whereas with an ungrounded neutral, if one of the main wires became grounded accidentally, contact with the other one would give the full voltage of the system. (3) Yes.

What is the best way to demagnetize a watch? H. S. W.

Mount the watch in a revolvable frame in front of one pole of a powerful electro-magnet arranged to be excited with direct-current. Revolve the watch at a high speed and then turn on the current gradually. After ten or fifteen seconds turn the current off gradually and take the watch out of the frame. If alternating current is available the watch need not be revolved, but may be held stationary in front of the magnet pole. In this case the magnet must have either a laminated core or none at all.

How can the correct running speed of a direct-current dynamo of known voltage be determined when there is no source of power available to drive the machine except a direct-current circuit? E. F. H.

Drive it as a motor from the supply circuit, being careful to use ample resistance in series with which to prevent it running at excessive speed in case it should be designed for a voltage lower than that of the circuit. If the voltage of the machine coincides with that of the circuit all of the starting resistance should be cut out, of course, letting the machine run at full speed. The speed as a dynamo should be about 10 per cent higher than the speed at which it runs as a motor.

Does a turbine water-wheel have the same power located at the top of the penstock, with a draft tube extending down to the tail water, that it would have if it were located at the bottom of the penstock with all of the weight of the penstock water on top of it? C. F. K.

Yes, provided the draft tube is absolutely air-tight. The volume of water in the draft tube has the same effect on the wheel as though it were on top of the wheel instead of beneath it. For example, if you assume that the water initially drops away from the wheel, this would form a vacuum between the water and the wheel and the "sucking" effect would be the same as though the mass of water in the draft tube were on top of the water wheel.

What is the most economical apparatus for operating series arc lamp circuits from a constant-potential, alternating-current source? (2) What apparatus of that class is easiest to maintain in running order? (3) Why are motor-generators not used for this purpose? T. E. G.

It depends on local conditions entirely; no general recommendation is possible. Both constant-current transformers and reactive regulating coils give satisfaction; the former has the advantage that the total secondary e.m.f. may be anything one chooses, whereas with the latter, the maximum secondary pressure is necessarily less than that of the constant-potential source. (2) Usually the automatic reactive regulator requires less adjustment and attention. (3) They are; their first cost and relatively low efficiency compared with either a transformer or a reactive regulator, however, prevent their general use for this purpose.

How can the windings of alternating-current fan motors be changed for different frequencies? (2) If the field of a direct-current motor is weakened and its speed therefore increases, does the armature take more current than before? (3) How can I tell whether an alternator is a three-phase or a three-wire, two-phase machine without testing with instruments of any kind? The machine has three collector rings. (4) Why are rotary converters sometimes provided with a compound-wound field? (5) I understand that the series field is never used in practice; is this true? W. H. S.

You cannot do so unless the stator is of the slotted-ring type, and even in that case it would be rather difficult. The winding would have to be changed so as to increase the number of poles in direct proportion to the increase in frequency. (2) Yes; provided the backward torque of the load remains the same or increases. (3) So far as we know there are no two-phase alternators with three collector rings. There are only two standard constructions; in one four rings are connected symmetrically to points in a closed armature winding, and in the other there are two distinct armature windings, each one connected to one pair of rings. A machine with three collector rings is either a three-phase alternator or a monocyclic machine. (4) and (5) The compound winding is used for regulating purposes; it may be left cut out in some instances, but that is not the intention of the manufacturers, of course.

What is the difference between the armature and field windings of a constant-potential generator and those of a constant-current generator. (2) What effect does line loss or drop in voltage have on shunt-wound and series-wound motors operating on the same circuit? (3) What is meant by a right-hand and left-hand armature winding? (4) Does it make any difference whether the exciting current enters at the inner or outer terminal of a field magnet coil or at which end of the bobbin, provided the current travels around the core in the proper direction? (5) In an electric locomotive with series-parallel control, operating on a 250-volt circuit, the voltage at the terminals of each motor is 125 when in series and 250 when in parallel; is the current when in series double the current when in parallel, or the contrary? (6) Does the starting resistance of a shunt-wound motor affect the voltage or the current of the machine, and is the effect the same in series and compound-wound motors? S. T. W.

There is not necessarily any difference in the armature windings, but the field windings are entirely different. The constant-potential machine is provided with either a shunt field winding or both shunt and series field windings, whereas a constant-current machine is provided with a series field winding only. (2) It reduces the speed of a series-wound motor almost in proportion to the drop in voltage; the speed of a shunt-wound machine is also reduced, but not to the same extent, because the lower voltage weakens the field, and this tends to keep the speed up. (3) A right-hand winding is one which if traced from a given commutator bar works progressively around the armature clockworks; a left-hand winding is of the opposite character. (4) No. (5) It depends entirely upon the load and speed; there is not necessarily any definite relation. If the machine were standing still and thrown on the line without any preliminary gradation the current with the motors in parallel would be four times that with the motors in series, but when the machine is running, the increase of current is not nearly so great because the change is made gradually and the machine speeds up. (6) The resistance affects the voltage at the terminals of the motor and this, of course, affects the current flow. The effect is the same in all types of direct-current motor.

SUCTION GAS PRODUCERS.

Producer gas power plants are built for generating out of a suitable fuel a mixture of carbon monoxide and hydrogen, which, if used in gas engines, permits an exceedingly advantageous utilization of the fuel. Much of the producer gas is made in what are termed "pressure gas producers" by evaporating water in a separate boiler and by leading the steam mixed with air by means of a steam jet, blower or fan through the glowing fuel, whereby the steam is decomposed to hydrogen and the coal burned to carbon monoxide. This mixture of combustible gases is led through a scrubber to a gas holder and thence to the engine.

The Nagel gas producers have been designed with a view to superseding this form

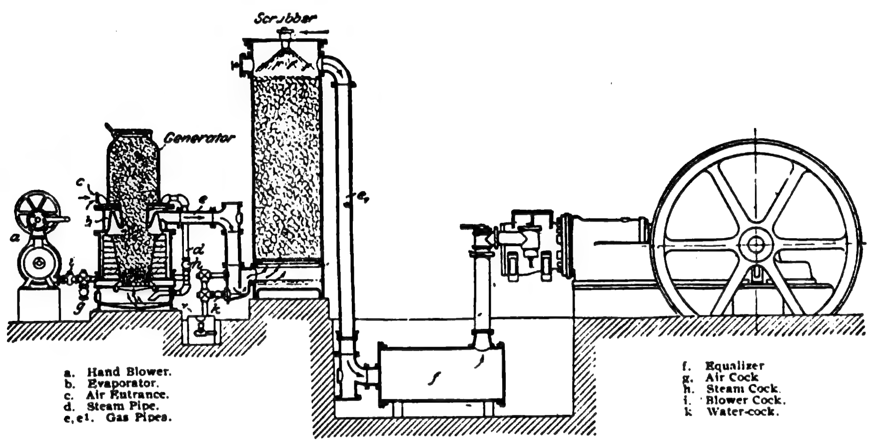


FIG. 1.—SUCTION GAS PRODUCER PLANT.

of gas producer. In this system air is drawn by the sucking action of the engine over hot water or steam, thence through the fuel bed, where it is converted into power gas, whence, after suitable purification, it passes to the engine. In the suction gas producer plant the boiler is supplanted by an evaporator, which in small plants is built on top of the producer and in large plants near the producer in the form of a tubular evaporator. This evaporator generates the steam required and utilizes the heat of the producer and of the gases. Hence it possesses an advantage over the older system, which requires the firing of a separate boiler.

A complete suction producer plant consists of a producer, an evaporator, an overflow water pot, a scrubber and an equalizer. The producer is provided with a hopper through which fuel can be filled into the producer without interfering with the working of the engine. Plants up to 25 horse-power in capacity are provided with a simple hopper so as to contain sufficient fuel for a working day. Plants above 25 horse-power and under 75 horse-power are provided with a bell hopper so as to insure a continuous running of the engine during the time of recharging. Plants above 75 horse-power are provided with an independent evaporator.

The operation of a producer plant may be followed from Fig. 1. Before starting the engine the fuel in the producer is caused to burn rapidly by means of a small hand blower, *a*, until the gas is burning well. This operation requires about ten minutes, after which the hand blower is stopped and the engine started in the usual way. The engine now draws by its own sucking action the necessary amount of air, thereby producing its own power gas. The air enters at *c* and goes through the evaporator *b*. Here it is saturated with steam and the mixture of air and steam passes through *d* under the grate of the producer through the fuel, through pipe *e* to the scrubber, and thence to the equalizer tank *f*, which is directly connected to the engine. The gas-making process continues so long as the engine is moving.

As the engine makes producer gas according to its load, it is claimed that only such an amount of air and steam is drawn through the producer as is necessary for generating the amount of gas required. At low loads less gas is made, and the whole system being under negative pressure, it is claimed that no gas can leak into the atmosphere. The only attention required by the plant is to fill the producer from one to four times a day, according to the size, and remove the ashes twice a day. The coal consumption is said to be regulated automatically and to be independent of the skill of the attendant, which is of undoubted advantage. Anthracite coal, charcoal or coke can be used for generating gas in the producer. It is estimated that 1 to 1¼ pounds of anthracite coal or charcoal or 1⅓ to 1½ pounds of coke are required to develop one horse-power-hour. The producers are made by Dr. Oskar Nagel, of New York City, and are built in sizes from 5 to 300 horse-power and over.

WESTINGHOUSE TYPE H POLYPHASE INDUCTION MOTOR.

The Westinghouse type H motor is designed for constant speed service and belongs to that class of induction motors without contacts or any connection whatever between the supply circuit and the rotating element. The starting mechanism is mounted on the shaft external to the frame, and consists of a device by means of which resistance is inserted in the winding of the revolving part when starting and gradually cut out as the speed increases until the winding is short-circuited. Thus by a gradual development the starting current becomes practically the running current, which is a very important feature on small systems where a constant voltage is essential and which would be considerably affected by throwing the motor suddenly on the line. The frame of the motor is a solid ring of cast iron with feet for supporting the machine. Slide rails may be used or not as desired. The core carrying the stationary windings is built up of steel punchings which fit the bore of the frame and which are firmly held together between two iron rings. Substantial brackets carrying the bearings for the rotating element are bolted to the cast iron frame, and may be fastened in four positions, permitting the motor to be mounted on the floor, side wall or ceiling, and the oil reservoirs to always be in the proper position. By means of oil rings revolving in the reservoirs copious lubrication is provided for the motor while in operation. To secure the starting characteristics above mentioned the secondary windings are similar to those of a polyphase generator. Insulated copper bars are inserted in the partially closed slots in the steel punchings of the rotor. These punchings are mounted on a cast iron spider which is keyed to the shaft. The overhanging tips of the teeth hold the bars in the slots. The end connectors are secured to the bars after they are in place and the leads are brought out through the hollow shaft to contacts in the starting device. This consists of a resistance which is cut in and out of the circuit by a sliding contact, and is so arranged that as the motor accelerates it may be gradually cut out

FIG. 1.—WESTINGHOUSE TYPE H INDUCTION MOTOR.

by pushing in the cylinder, until for normal running the winding is short-circuited. The starting device may be operated by a lever rigged in a manner similar to an ordinary belt shifting device. The case of the starter is a cast iron cylinder of enclosed construction, and, being dust-proof and sparkless in operation, may be used with impunity in the presence of inflammable vapor or dust-laden air. These motors are built for two and three-phase circuits in sizes from 5 to 50 horse-power, for 3000 and 7200 alternations. Standard voltages are 100, 200 and 400 for machines up to 20 horse-power, and 200 and 400 volts from 20 to 50 horse-power.

New Apparatus and Appliances

A NEW LINE OF SMALL POWER MOTORS.

The application of electric motors to general power purposes involves so many different conditions that motors for successful general use must now possess, to a large degree, all those qualities which hitherto have been considered necessary only in motors intended for special severe service. This idea has been followed closely in the design of the new line of General Electric Company's small CQ motors. They are built in sizes ranging from ¼ horsepower to 20 horsepower, and are adapted to practically all conditions of service, as their design has been laid out with special reference to simplicity and durability in constructon and reliability in operation. The customary form of bearing support for small motors is here utilized, but with some attention paid to appearance as well as strength and rigidity. The end shields are simple in form and of large section, giving rigidity to the frame. They may be rotated in either of four positions differing 90° from each other to meet the requirements for various positions of installation. The bearings encased in the end shields are lubricated by oil flooding rings revolving in the oil reservoir below the shaft. The linings are single castings of hard composition of ample bearing surface. The general form of the motor secures a low centre of gravity of the complete motor and a short magnetic circuit, which, combined with high-grade workmanship, gives the CQ motor a notable efficiency for its capacity and enables the maker to produce a compact machine free from vibration. The cylindrical soft cast steel magnetic yoke is provided with feet which allow rigid connection with the support of the motor. The pole pieces are separate from the yoke and fastened to it by through bolts, permitting ready removal when repairs are necessary. The extended tips of the pole pieces hold the field coils rigidly in position. One evidence of the care used in the design of these motors is to be found in the construction of the armature. The armature body is insulated in a manner similar to that employed in the standard General Electric railway motors. The insulation is tough and impervious to moisture and practically indestructible. Thorough tests of the insulation of the copper wire coils are made before placing them in slots punched in the armatture disc in

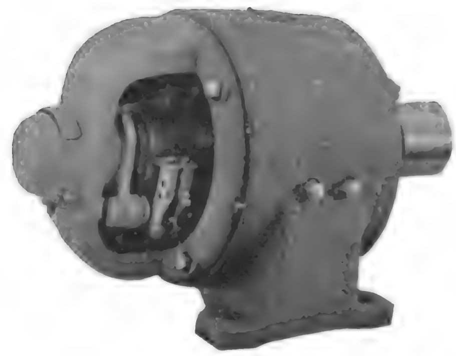


FIG. 2.—GENERAL ELECTRIC "CQ" MOTOR.

which they are retained by steel binding wires. The arrangement of the windings in the slots is such that a large surface of copper is provided in the position best calculated to dissipate the heat and ensure cool running and high efficiency. In the larger sizes air ducts are provided for ventilating the cores and windings. The steel laminations are clamped rigidly between two cast iron spiders or end plates which have flanges to support the extended ends of the armature coils. The motors operate with practically no sparking under variations from no load to full load and without shifting the brushes. The speeds of the CQ motors have been chosen to permit direct belting to line shafts running at ordinary speeds without the use of intermediate countershafts. It will be recognized that the chief advantage of slow speed in electric motors is the reduction of losses due to belt wear on bearings and commutator, but it must be borne in mind that a decrease in speed must necessarily reduce the output of a motor for a given size and weight of material. When a lower driving speed is desired than can be obtained with a standard CQ motor, a belt tightening apparatus is furnished which allows a driving pulley smaller than the standard one to be used and at the same time secures sufficient contact to enable the full power of the motor to be transmitted. This is particularly serviceable when a very short driving belt must be used. The loose pulley may be adjusted to any lead of the belt and in many cases avoids the adoption of a gear drive when it is undesirable.

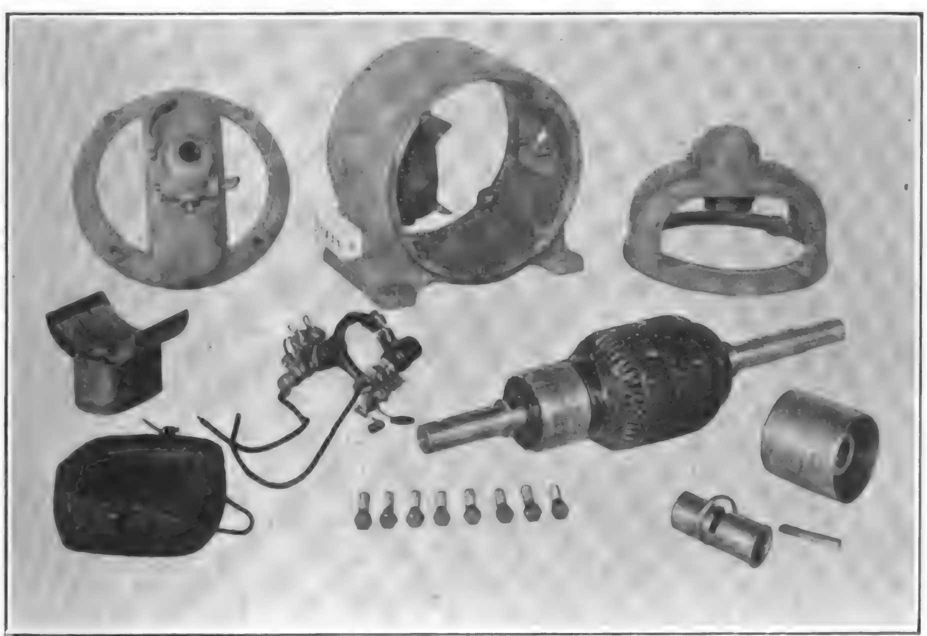


FIG. 1.—GENERAL ELECTRIC "CQ" MOTOR DISASSEMBLED.

THE UNIVERSAL DIRECT-CONNECTION PANEL.

Among the many annoying details of the interior wiring business, the troubles due to panel boards are, perhaps, the most difficult to overcome. It is evident that the panel is the most conspicuous part of a concealed-wiring installation, and that the use of make-shift apparatus for this portion of the equipment should not be tolerated. To procure a suitable panel from the manufacturer, frequently involves a delay in the completion of the undertaking, because it is almost out of the question for a single dealer to keep on hand a complete stock when the requirements of the various installations are so essentially different. The universal direct-connection panel, illustrated herewith, has been designed to eliminate the trouble mentioned above. This panel can be used for two-wire or three-wire work, with plug, link or enclosed fuses. Each tablet being adaptable in this way, it is only necessary for the contractor or dealer to have on hand a few sizes of fuses and switch panels to be certain of supplying from the stock exactly the board required. In addition to this feature these boards are claimed to be smaller than any other ap-

FIG. 3.—SIX-CIRCUIT TABLET.

proved tablet at present to be found on the market. In the construction of these boards, the circuit terminal of the switch base is carried over the bus-bar and formed into a fuse plug receptacle, so located that the fuses make direct connection with the

bus-bar. By this means the bus-bars are covered by the branch bars, and an accidental short circuit involving the mains is practically impossible. When the fuses are removed all the exposed metal work except the main terminals is disconnected. This panel is manufactured by Johnson & Morton, Utica, N. Y.

"COMMERCIAL" INDUCTION MOTORS.

The Commercial Electric Company, Indianapolis, Ind., is placing on the market a line of induction motors, in the design of which the services were retained of Mr. H. M. Hobart, of London, the well-known authority on induction motor design. The

FIG. 4.—COMMERCIAL INDUCTION MOTOR.

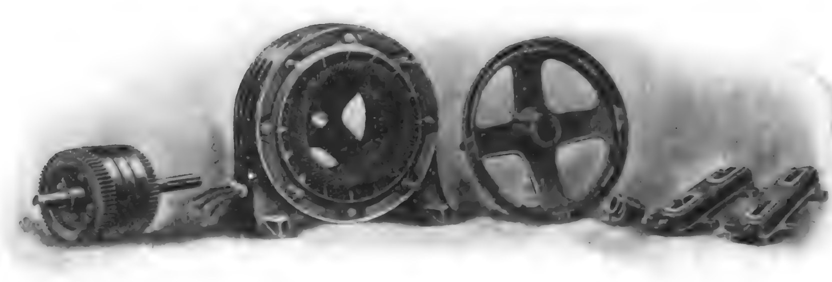


FIG. 5.—INDUCTION MOTOR DISASSEMBLED

details of this motor are illustrated in Fig. 5 and the complete motor is shown in Fig. 4. It is well known that in order to produce a high power factor in induction motors it is essential that there shall be a limited clearance between the rotor and stator. In the present motor the design of the stator frame and stator head is such that an equal division of this clearance is always secured and maintained, it being an impossibility to assemble the machine in such a manner as to give the rotor an unequal air-gap on opposite sides. In order to reduce the wear of the rotor shaft to a minimum, very large bearing surfaces have been provided. The bearings are also so designed that if the operator should flood them with oil no damage to the machine could occur. The bearing linings are duplicate and interchangeable; thus, it is claimed, making the replacement of the bearing a much more simple and less expensive matter than is involved in the accurate readjustment of "adjustable" bearings. The shaft is accurately ground to gauge, the bearings are polished and the rotors are mounted on the shaft by means of hydraulic pressure. Ventilating apertures are provided across the faces of the stator and rotor cores, thereby causing a free circulation of air and insuring cool operation. The motors are manufactured in all standard ratings from 5 horse-power to 200 horse-power. A line of small single-phase self-starting induction motors is also made in ratings from 1 horse-power to 5 horse-power. The machines are made for all standard voltages for both two and three-phase circuits and for frequencies of from 25 to 60 cycles.

CEILING ROSETTE WITH ENCLOSED FUSE.

Fig. 6 herewith shows a view of the General Electric Company's ceiling rosette

FIG. 6.—CEILING ROSETTE WITH ENCLOSED FUSE.

which has several points of interest. This rosette has been especially designed for 250-volt work. It takes enclosed glass tube fuses. Its appearance is similar to that of the other rosettes produced by this company, and like them it has substantial porcelain parts and punchings. There is ample space in the cover for the knot in the flexible cord, so there is no danger of the lamp falling. The opening in the cover permits of the use of standard reinforced flexible cord. The clips receiving the enclosed glass tube fuses are strong and durable.

LARGE CONTROLLER.

Fig. 7 herewith is said to illustrate the largest capacity electric motor controller ever built, it being one of two designed and constructed by the Cutler-Hammer Mfg. Co., of Milwaukee, for the Carnegie Steel Co., of Pittsburg. The panels are of white Italian marble, their total dimensions being 11 feet long and 7 feet 8 inches high.

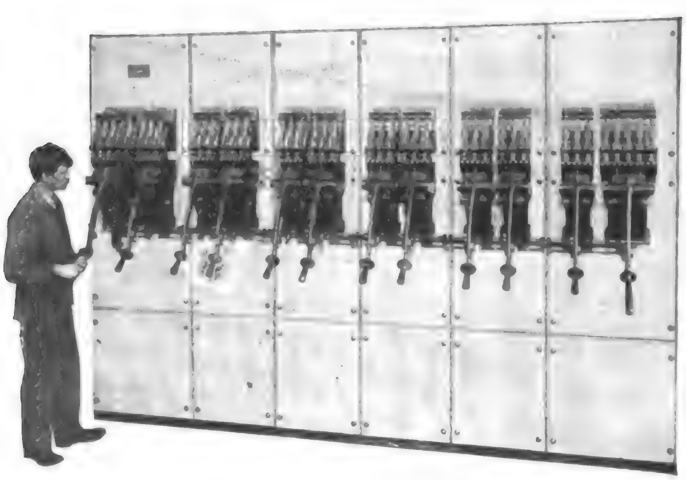


FIG. 7.—LARGE CUTLER-HAMMER MOTOR CONTROLLER.

The first and last switches have a continuous capacity of 10,000 amperes, and the intermediate switches a continuous capacity of 6000 amperes. The levers with which the switches are operated are a trifle over three feet long, but by means of a toggle joint action they can be easily thrown into contact. Before these two controllers were built there was but one extra large capacity controller in the United States, that being installed over a year ago in the plant of the Pittsburg Reduction Company at Massena, N. Y. The resistance for these starters is composed of steel rails arranged in a rack 19 feet high, 30 feet long and 14 feet wide.

AUTOMATIC NUMBERING MACHINE.

In the new model of automatic numbering machine brought out by The Bates Machine Company, of New York City, the customary iron or brass frames and cases are superseded by steel. It is only necessary to move the indicator until the word representing the class of numbering desired appears in the window of the front plate. When set "Consecutive" the number advances from 1 to 999,999, changing all the wheels automatically. When set "Duplicate," each number is printed twice and is then advanced consecutively. When set "Repeat" the automatic mechanism is detached and the number is repeated continu-

123456

FAC SIMILE IMPRESSION

FIG. 8.—NUMBERING MACHINE.

ously. Only the standard size and style of figures, shown under the illustration, are furnished in the stock machines. Drop-ciphers with their springs and pins have been eliminated, and the wheels themselves

are made depressible to provide the necessary spaces preceding the unit wheel. The plunger, which is made of Bessemer steel, is shielded from view when in its normal position. The figures are automatically inked before each impression from a thick felt pad, the padholder of which may be instantly removed from the machine for re-inking. An accurate gauge plate assures printing precisely upon a line.

AUTOMATIC ENGINE STOP AND SPEED LIMIT.

The Locke Regulator Company, of Salem, Mass., has placed on the market an automatic engine stop and speed limit system which is illustrated herewith. The main shut-off valve is actuated by the auxiliary electric valve shown in section by Fig. 9. The purpose of this valve is to pro-

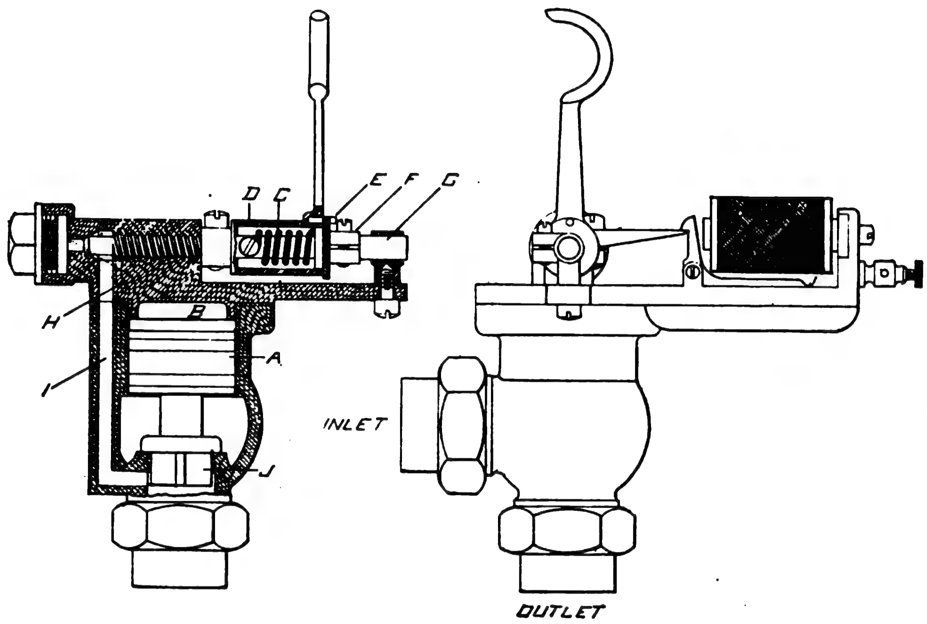


FIG. 9.—LOCKE AUXILIARY ELECTRIC VALVE.

vide means of shutting off steam from convenient points electrically or automatically by the speed limit whenever the speed increases above normal. For this purpose a balance valve is used with a cylinder and piston at one end; whenever steam is exhausted from the top side of the piston by the electrically actuated auxiliary valve, the piston is forced to the upper end of the cylinder by the steam pressure, thereby closing the main valve. The only adjustment necessary after closing is to latch the auxiliary valve. When this is done the pressure above the piston will become equalized, allowing the main valve to be forced open to its normal position by the steam acting on the differential poppits. The operation of the auxiliary valve shown in Fig. 9 is as follows. Steam enters at the side of valve marked inlet, passes above piston *A* and fills space *B*. Whenever the valve is electrically tripped, spring *C* uncoils, rotating spring barrel *D*, which carries pin *E*. This pin strikes cam *F*, which is clamped to the auxiliary valve spindle *G*, which rotates one-fourth of a turn, removing the valve from its seat 1/16 inch and exhausting steam from space *B* through passages *H* and *I* to the outlet end of valve. As piston *A* is larger than poppet *J*, the poppet will be forced open, allowing steam to pass through the valve. This in turn exhausts steam from the top side of the piston of the main shut-off valve, closing the same. The object of the speed limit governor is to automatically close an electric circuit whenever the engine speed increases above the normal, thereby tripping the electric device of the main shut-off valve, closing the same. For this purpose the Pickering style of governor is used, which is designed to be belted to the engine shaft and connected in wiring circuit as any ordinary push button would be.

NATIONAL ELECTRICAL CODE STANDARD ENCLOSED FUSES AND CUT-OUTS.

The General Electric Company is now furnishing a complete line of National Electrical Code standard enclosed fuses and cut-outs, ranging from 3 to 600 amperes for both the 250 and 600 voltages. The cut-outs and fuses are uniformly compact and durable, and the insertion or removal

FIG. 10.—250-VOLT, 31-60 AMPERE FUSE.

of the fuses is easy and safe. For fuses rated from 3 to 30 amperes, 250 volts, cut-outs similar to the Edison plug cut-outs are furnished, and for fuses from 31 to 60 amperes, 250 volts, two and three-wire, main-line and single-line cut-outs are supplied. All other sizes of fuses are pro-

FIG. 11.—250-VOLT, 65-100 AMPERE' FUSE.

vided with single pole cut-outs. With all cut-outs are used the G. E. wrought copper cable terminals, with the exception of the 30-ampere, 250-volt sizes. These are provided with washer and screw terminals. The fuses are of the well-known enclosed-fuse type, ferrule or knife-blade contacts being used, according to the requirements of the code. The knife-blade type, in addi-

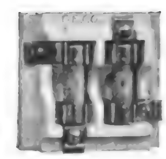


FIG. 12.—TWO-WIRE, CROSS-OVER, 250-VOLT, 3-30-AMPERE CUTOUT.

tion to the standard parts, has a brace placed in each end of the tube to engage

FIG. 13.—250-VOLT, 30-AMPERE RENEWABLE FUSE PLUG.

the screws which hold the end caps in place. The brace is rigidly attached to the contact blades. This forms a strong mechanical

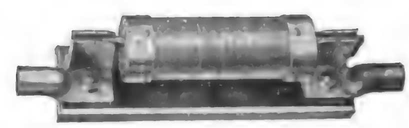


FIG. 14.—SINGLE-POLE, 600-VOLT, 401-600-AMPERE CUTOUT.

joint which does not depend solely upon the shearing strength of the fibre tube. The knife blade contacts are of punched

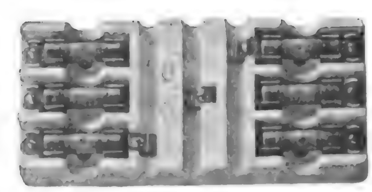


FIG. 15.—THREE-WIRE, DOUBLE-BRANCH, 250-VOLT, 3-30-AMPERE CUTOUT.

copper, and when used with the standard switch clips provide the best form of contact. The parts being copper, of high con-

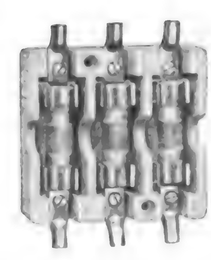


FIG. 16.—THREE-WIRE, MAIN LINE, 250-VOLT, 3-30-AMPERE CUTOUT.

ductivity, generously proportioned, the heating is reduced to a minimum. In the ferrule type the contacts are made of phosphor bronze clips designed to give the utmost contact and elasticity in the smallest

possible space. The renewable fuse plug consists of a brass tube, with the lower end threaded to fit the standard screw shell, and the upper part insulated by a porcelain shell. There is also in the upper end, a spring clip which receives the ferrule contact of the reload, the ferrule on the other end forming the center contact of the plug. The reloads are the 30 and 60 ampere, 250-volt enclosed fuses.

RECEPTACLE FOR MOULDING WORK.

This receptacle for moulding work recently put on the market by the General Electric Company has a number of commendable features. The terminals are concealed, preventing possibility of a short circuit and adding largely to the attractiveness of its appearance. It is so arranged as to be adaptable for a shade holder. There are no live parts on the back, and the cover and base are held firmly by two screws to the surface to which it is attached.

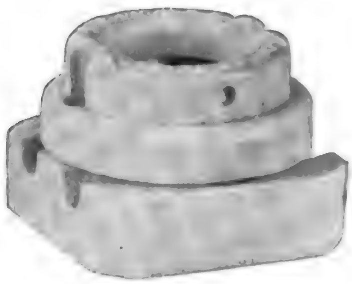


FIG. 17.—RECEPTACLE.

MODEL FLANGE CLAMP.

The clamp shown herewith has been brought out by James McCrea & Co., of Chicago, Ill., for repairing leaks in steam pipes under pressure when it is impossible to shut down and renew the packing. The mechanism may be thoroughly understood by reference to Fig. 18. The clamp consists of an outer ring made in two sections, in which the compression screws are placed; an inner or compression ring made in four sections, with a lug on each section to correspond with a slot in the outer ring, thus assuring no displacement while attaching. A gasket accompanies the outfit which is placed around the flanges over the leak. Should, by any reason, the leak appear around the bolts holding the flanges tother, it is an easy matter to pack around the bolt with a little hemp soaked in red or white lead, and use a common iron washer.

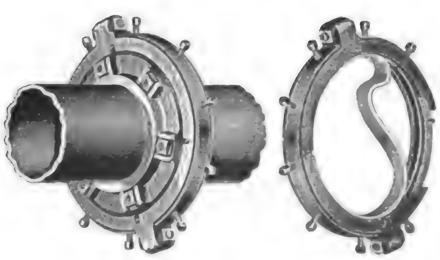


FIG. 18.—FLANGE CLAMP.—FIG. 19.

CURTIS STEAM TURBINES IN JAPAN.

With the industrial awakening of Japan has come a need for electric power for manufacturing, transportation and lighting. Japanese engineers are wide awake, and their enterprise is nowhere more clearly indicated than in their adoption of steam turbine electric generating units.

On July 29, 1904, the first shipment of steam turbines arrived in Japan via the steamship *Korea*, from San Francisco. They were of 500 kilowatt capacity, of the Curtis type, and were for operating the Shigai Railway in Tokio. Four weeks from their arrival they were in full operation. As significant of the success of these units, there have been ordered by the Japanese from the General Electric Company of New York, thirty-seven Curtis steam turbines with electric generators with a total normal capacity of more than 35,000 horse-power. Of these, eleven units are now installed and in satisfactory operation.

AMERICAN DYNAMOS IN AN ORIENTAL PRINTING HOUSE.

The accompanying engraving shows a portion of the power plant of Bureau of Public Printing at Manila, P. I.

The plant includes two standard 50-kilowatt Crocker-Wheeler electric generators. One was installed last year and the other in 1901. It is significant of the simple design of these machines that they are operated by natives whose mechanical experience seldom comprehends anything more intricate than a wooden plow. The native shown in the picture is quoted by Mr. Tatum, the engineer in charge, as saying, "Me saber Crockerne-Whelem electricidad maquina." ("I know all about Crocker-Wheeler electric machines.")

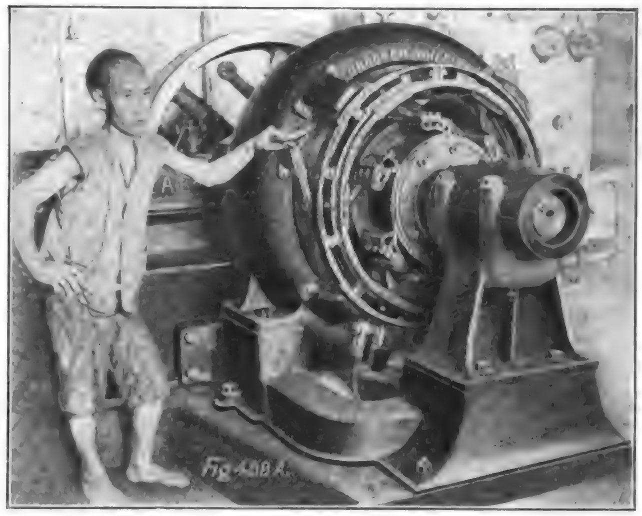


FIG. 1.—GENERATOR IN MANILA PRINTING OFFICE.

ECONOMY IN LUBRICATION.

Economy in the use of lubricating oils is a matter of no mean importance in a central station or other power plant, the total cost of lubrication being usually the largest of the subordinate items. The attention being given nowadays to this feature of power plant economy is indicated by the careful arrangement of lubrication details in some of the modern installations of large size. For example, the Lackawanna Steel Company, of Buffalo, N. Y., is equipping its power plants to obtain the utmost economy in oil handling and consumption. At these mills there are installed 48,000 horse-

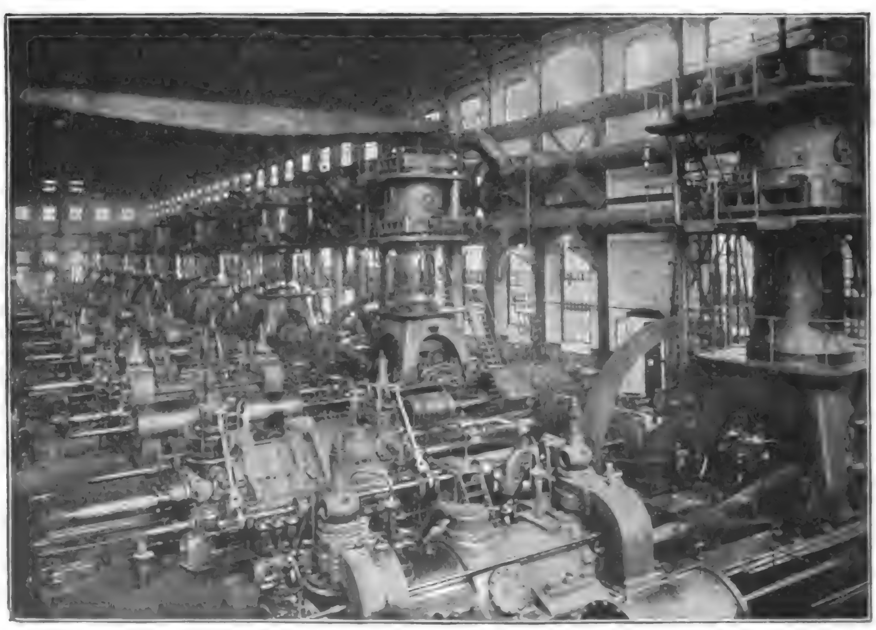


FIG. 2.—LACKAWANNA STEEL COMPANY'S POWER STATION IN BUFFALO

power of engines; five Allis-Chalmers vertical cross-compound steam engines aggregating 16,000 horse-power, drive roll trains, etc., and sixteen blowing engine units are driven each by a 2,000-h.p. Koerting gas engine. The accompanying illustration shows the interior of one of these plants.

The complete power installation of 48,000 horse-power is being equipped with the "White Star" continuous oiling system, manufactured by the Pittsburg Gauge & Supply Company, of Pittsburg, Pa. By this system the oil is distributed continuously to all bearings, keeping them constantly supplied with just the amount of oil required for best results. All drips and used oil are drained away to a "White Star" filter, which constitutes a prominent feature of the system. In the filter it is cleaned of all impurities and is then pumped to a storage tank, whence it is returned to the lubricating circuit. Loss of oil is said to be entirely avoided, the only means of escape from the system being by leakage due to excessive wearing of the bearings.

As an indication of the merits of such a system it is interesting to consider the case of the Union Steel Company's power plant. About two years ago this plant, which is located at Donora, Pa., was equipped with the "White Star" system. Previous to this installation, a 38 and 75 by 60-inch twin tandem compound condensing engine of the Porter-Allen type required an average of 1,050 gallons of engine oil per month. The application of the "White Star" system is said to have reduced the consumption to an average of 503 gallons under similar conditions—a saving of more than 52 per cent. In this same plant, on two 30 and 60 by 48-inch engines, the oil consumption is said to have been reduced from 400 gallons to 195 per month, operating full. As a further item of saving directly creditable to the "White Star" system, the services of three oilers required under the old regime were dispensed with from the start.

NEW BOOKS.

STEAM TURBINES. By Dr. A. Stodola. New York: D. Van Nostrand Company. Cloth; 434 + xvi pages, 6 ins. x 9 ins.; 241 illustrations. Price, $4.50.

The size and scope of this book preclude anything like a comprehensive review. It is a translation by Dr. Louis C. Loewenstein of the second edition of the work, which was originally published in German. The author discusses, in the sequence given, the Elementary Theory of the Steam Turbine; the Theory of the Turbine Thermodynamically Considered; the Construction of the Most Important Turbine Parts; Steam Turbine Types, and Special Problems of Turbine Theory and Construction. There is also an appendix on The Future of the Heat Engine, in which are discussed the entropy diagram for steam; the economy of the heat engine; the practical criterion of heat utilization, and the gas turbine. Three entropy diagrams are printed on large sheets and stored in a pocket in the back cover.

ELECTRICIANS' HANDY BOOK. By T. O'Conor Sloane. New York: The Norman W. Henley Publishing Company. Flexible leather; 761 pages 4½ ins. x 6½ ins.; 556 illustrations. Price, $3.50.

This book embodies a praiseworthy effort to put in form for ready reference complete fundamental information on all practical branches of electrical engineering. The first chapter is devoted to an explanation of the elementary mathematics necessary to any intelligent study of engineering principles; the author next takes up "Electric Quantity and Current"; then "The Electric Circuit," "Ohm's Law," "Electrochemistry," "Primary Batteries," "Storage Batteries," "The Magnetic Field of Force," "Magnets," "Induction," in the sequence named. Then follow chapters on the principles of direct-current machinery, alternating-current phenomena and machinery, care of dynamos and motors, and explanations of the principles and construction of minor apparatus, such as arc and incandescent lamps, measuring instruments, etc. While the book contains a rather unnecessary quantity of academic information, this can do no harm and the practical portion of the contents is in nowise sacrificed in order to get it in.

PERSONAL.

MR. J. R. McCOLL, until recently associate professor of steam engineering at Purdue University, has accepted a responsible position in the engineering department of the American Blower Company, Detroit, Mich.

MR. FRANCIS RAYMOND, formerly connected with the General Incandescent Arc Light Company, has been appointed the Chicago representative of the Moloney Electric Company, St. Louis, Mo. Mr. Raymond will occupy a suite of offices in the Old Colony Building.

MR. ROBERT R. LIVINGSTON, who was formerly connected with the Allis-Chalmers Co., and more recently with W. S. Barstow in electrical engineering work, has accepted a position with the Engineering Company of America and will make his headquarters at 74 Broadway, New York City.

DR. F. A. C. PERRINE, the well-known consulting engineer, has decided to go extensively into isolated plant work, covering the general engineering and operating problems of electric lighting and power development and operation. Dr. Perrine will be directly assisted in this work by Edwin H. Seaman, who will attend to the minor details.

MR. HALBERT P. GILLETTE, formerly associate editor of the *Engineering News*, and MR. GEORGE H. GIBSON, recently connected with the departments of publicity of the International Steam Pump Company, B. F. Sturtevant Co. and the Westinghouse companies, have formed a partnership as advertising engineers under the name of the George H. Gibson Co. The company is not an advertising agent in the usual sense, but conducts a firm's advertising in the same manner as would a department in the firm's own offices, the actual purchasing of space and printed matter being entirely in the client's hands. The company has opened offices in the Park Row Building, New York City.

MR. W. E. HARRINGTON has severed his connection as vice-president and general manager of the New York & Philadelphia Company and joined the forces of J. G. White & Co., of New York, as operating manager. Mr. Harrington has had an exceptionally broad experience in the engineering field, particularly in the operation of electric railway, lighting and gas properties, and as operating manager of J. G. White & Co. he will supervise all of the railway, electric lighting, gas and other properties operated by this company. Mr. Harrington is an active member of the Executive Committee of the American Street Railway Association and a member of the American Institute of Electrical Engineers. He will make his headquarters at the New York office of J. G. White & Co., 43 Exchange Place.

TRADE PUBLICATIONS.

PANEL BOXES. H. T. Paiste Co., Philadelphia, Pa.—This is bulletin No. 25, devoted to panel cut-outs, entrance switches and other specialties.

RECORDING WATTMETER. General Electric Company.—This is bulletin 4415, illustrating and describing the type C Thompson recording wattmeter.

ELECTRIC HEATERS. General Electric Company.—A pamphlet of pocket size describing the electric coffee percolater manufactured by the G. E. Company.

SECOND-HAND MACHINERY. J. H. Thompson, Jr., New York.—Bargain list No. 4 of second-hand electrical and steam machinery ready for immediate delivery.

STEAM ENGINES. Ball Engine Company, Erie, Pa.—A well-executed pamphlet of pocket size, describing the new designs of engine brought out by this company.

FLANGED PIPE JOINTS. Crane Co., Chicago, Ill.—Bulletin No. 7FJ, illustrating and describing the various styles of joints used in attaching flanges to wrought pipe.

SERVICE CUT-OUTS. General Electric Company.—Bulletin 4416, superseding bulletin 4302 and illustrating and describing the company's triple-pole service box arranged for enclosed fuses.

ELECTRIC HOISTS. General Electric Company.—Bulletin 4412 illustrating and describing the various forms of Lidgerwood-G. E. hoists for building operations and general construction work.

TOOLS. The Cleveland Twist Drill Company, Cleveland, Ohio.—A catalogue of standard size, illustrating the sets of tools designed by this company expressly for turret lathes and screw machines.

MOTORS AND DYNAMOS. The Barriett Electric Company, Cincinnati, Ohio.—Bulletin No. 4 containing brief descriptions of the various types of direct-current motors and dynamos built by this company.

MODERN VENTILATION. The Electric Ventilating Company, Chicago, Ill.—A booklet containing a brief discourse on the science of ventilation, and describing the system of ventilation controlled by this company.

ELECTRIC SPECIALTIES. — The Trumbull Electric Manufacturing Company, Plainville, Conn. A supplement describing the Type A switches, cast terminal lugs, fuse holders and extension posts made by the Trumbull Co.

VALVES. Crane Co., Chicago, Ill.—Circular No. 4SDV, describing the Crane removable spring-disc brass valves. These are made in the globe, angle and cross patterns and are suitable for working pressures up to 150 pounds.

ELECTRIC HEATERS. General Electric Company.—A small folder describing the electric flatirons of the enclosed-cartridge unit type for laundry or household use. These operate at 95 and 125 volts and consume 500 watts.

CRANE MOTORS. Sprague Electric Company, New York.—Bulletin No. 223, describing the Type N motors, which are specially designed for crane service. The bulletin is well printed and handsomely illustrated.

SMALL MOTORS. Crocker-Wheeler Co., Ampere, N. J.—Bulletin No. 60, superseding Bulletin No. 42, and describing the line of Form L motors manufactured by this company. These motors range in size from ¼ to 3 horse-power.

TURBINE PUMPS. General Electric Company.—Bulletin 4414, superseding bulletin 4409 and devoted to electrically driven turbine house pumps. These consist of Worthington house pumps direct connected to G. E. shunt-wound motors.

AUTOMATIC TELEPHONES. Automatic Electric Company, Chicago, Ill.—A reprint describing the new automatic telephone system built and installed by the Automatic Electric Company for the Home Telephone & Telegraph Company, Los Angeles, Cal.

REGULATING AND REVERSING CONTROLLERS. Westinghouse Electric & Manufacturing Company.—Circular No. 1108, illustrating and describing the Westinghouse regulating and reversing controllers for both alternating and direct-current motors.

INDUCTION MOTORS. Century Electric Company, St. Louis, Mo.—Bulletin No. 5, describing the single-phase alternating-current motors brought out by this company. These are built in sizes ranging from ¼ to 10 horse-power and for 25, 60, 100 and 133 cycles.

CABLING AND ARMORING MACHINES. Aiton Machine Company, New York.—Bulletin No. 85, illustrating and describing the four-head tandem cabling and armoring machine used for the manufacture of concentric cables of bare or insulated iron, steel or copper wire and for armoring purposes.

SINGLE-PHASE INDUCTION MOTORS. The Emerson Electric Manufacturing Company, St. Louis, Mo.—This is bulletin 3108 describing the Emerson Class 32 F A single-phase induction motors. The motors are of the condensed type with full-load automatic start and are built in sizes of ⅙ and 1/6 horse-power.

CALENDAR. Crouse-Hinds Co., Syracuse, N. Y.—A hanging calendar on the cardboard mount of which are shown pictures of the Empire State Express and the Hawley time register, one traveling at the rate of a mile a minute and the other drawing on a properly graduated chart a line one inch long for every hour that an employee works.

DIRECT-CONNECTED GENERATING SETS. Crocker-Wheeler, Co., Ampere, N. J.—Bulletins 56 and 57, supplementing bulletin 55 and describing Crocker-Wheeler generating sets. In one the prime mover is the Case engine built by the New Britain Machine Company, New Britain, Conn., and in the other the engine built by the W. D. Forbes Company, Hoboken, N. J., is used.

THREE-PHASE TRACTION SYSTEM. The Railway Electric Power Company, New York City.—A publication setting forth the characteristic features and advantages of the Ganz three-phase alternating-current traction system, with particular reference to the results obtained from its three years' use abroad. The company controls the American patents for the Ganz system.

SILVEY STORAGE BATTERY. The Dayton Manufacturing Company, Dayton, Ohio.—Bulletin No. 130, published by the Storage Battery Department of the Dayton Manufacturing Company and containing information relative to the use of the Vilvey storage battery in connection with isolated lighting plants. Diagrams of connections are given for the various Silvey systems.

COMMON-BATTERY NON-MULTIPLE SWITCHBOARDS. The Kellogg Switchboard & Supply Company, Chicago, Ill.—A handsomely executed catalogue of standard size, designated Bulletin No. 11, illustrating and describing the various types of Kellogg common-battery non-multiple switchboards and their accessories. The bulletin also contains diagrams of connections printed in two colors.

BUSINESS NEWS.

THE AMERICAN BLOWER COMPANY, Detroit, Mich., has received from the National Tube Company a large and important order for immediate execution, embracing heating equipment for the tube company's five new butt weld mills at Loraine.

THE ABBOTT ELECTRIC COMPANY, Boston, Mass., has added a supply department to its business. The company carries a line of motors in sizes ranging from 1-12 to 10 h.p., as well as rheostats, controllers, circuit-breakers, ceiling and desk fans, switchboards and storage and dry batteries.

ECONOMICAL ELECTRIC LAMP COMPANY, New York City, is bringing out something entirely new in the way of a window demonstrator which is termed a "silent salesman." This is an attractive automatic device for showing how the light may be turned up or down by using "economical" lamps.

THE RISDON-ALCOTT CO., Mount Holly, N. J., reports that it has just shipped to the Cramer Electric Company, Hailey, Idaho, an 800-h.p. turbine unit consisting of three wheels on horizontal shafts for setting in a concrete flume. These wheels are to be direct-connected to a Crocker-Wheeler generator.

THE LAGONDA MANUFACTURING COMPANY, Springfield, Ohio, reports that it has been so overcrowded with orders that it was necessary for them to run their factory all night during the greater part of the month of July. The increased work necessitated the employment of two sets of men for operating the machines and doing bench work.

CROCKER-WHEELER CO., Ampere, N. J., reports that it is in receipt of an order for a 200-kilovolt-ampere, three-phase, 60-cycle, engine-type, alternating-current generator for the Ivorydale (Ohio) lighting and power plant of the Proctor & Gamble Co. This machine is a duplicate of the first Crocker-Wheeler alternator ever built, which was installed ten months ago in the Atlanta plant of the Proctor & Gamble Co.

WORCESTER ELECTRIC MANUFACTURING COMPANY, Worcester, Mass., has recently added another story to its factory, which will give the company over 5000 square feet of additional floor space. The company manufactures a line of knife switches, switchboards, panel boards, cabinets, combination switches, fuse blocks, etc., and the additional space was greatly needed, since in order to make immediate shipments it was necessary to carry a large stock of slate and ready-to-assemble panel boards and switches.

THE MORSE CHAIN COMPANY, Trumansburg, N. Y., is building at Ithaca, N. Y., a plant of five times the capacity of the present one. The old plant was originally started for the manufacture of bicycle chains, but in 1901 the company brought out its high-speed, silent-running chain, and since that time has had a rapidly growing business. In the line of power transmission the Morse Co. has in service chains transmitting over 75,000 h.p. and is furnishing drives up to 500 h.p. for a single transmission.

CRESCENT ELECTRICAL MANUFACTURING COMPANY, Rochester, N. Y., states that it has been compelled to increase its factory space and to add new machinery owing to the demands for its products. The company has taken up the manufacture of switch and panel-boards. This department, we are informed, is in charge of one of the most expert designers and builders of this class of work in the country. The company has also added to its regular lines a number of porcelain specialties, fuse-blocks, etc.

THE CHANDLER & TAYLOR CO., Indianapolis, Ind., has recently secured contracts for its enclosed self-oiling, direct-connected engines in the following institutions: Purdue University, Lafayette, Ind.; Indiana State Normal School, Terre Haute, Ind.; Girls' Industrial School, Indianapolis, Ind.; Michigan College of Mines, Houghton, Mich. These engines are built in accordance with the recommendations of the Society of Mechanical Engineers and the American Institute of Electrical Engineers for direct-connected units.

THE PELTON WATER WHEEL COMPANY, New York and San Francisco, reports new orders as follows: Homestake Mining Co., Lead, S. D., an 800-h.p. Pelton wheel unit, direct connected to an electric generator. The Nevada Power Mining & Milling Company has contracted for an additional Pelton wheel of 3,000-h.p. maximum capacity, the wheel being direct-connected to an electric generator and operating under a head of 990 feet. This company is now installing two Pelton wheels for direct connection to 750-k.w. generators and proposes to transmit power to Tonopah and Goldfield, Nev. Through Mitsui & Co., San Francisco, an order was placed for a 500-h.p. wheel for use in an electric light station in Japan.

THE MARINE ENGINE & MACHINE COMPANY, Harrison, N. J., has removed its offices to 126 Liberty Street, New York, where they occupy the entire fourth floor. The company has recently secured the following contracts: Four direct-connected electrically controlled elevators for the Hutchins Building, Fifth Avenue and Thirty-ninth Street; eleven electric elevators for the College of the City of New York; one tandem electric elevator for building of the New Orleans railways; one electric elevator in the Hartford Building; two for the Pennsylvania Railroad Company at Long Island City; one electric elevator for the Willett Realty Company's new building, West End Avenue and Eighty-second Street, and one automatically controlled residence lift for E. W. Luster, 16 East Sixty-seventh Street.

THE PELTON WATER WHEEL COMPANY, San Francisco and New York, has just closed a contract for a water wheel installation for D. J. Aguirre & Co., of Tepic, Mexico. The head available is 174 feet, and the plant consists of two Pelton wheel units of 700 h.p. capacity each, direct connected to General Electric generators; also two Pelton wheel units for driving exciters. Sturgess oil type governors will be used. Pelton wheels are employed at the sugar plantation of Aguirre & Co., there being six wheels at present employed for driving heavy sugar rolls by means of direct connection, machine shops, electric lighting plant, etc. The company states that its export trade in Pelton wheels has largely increased in the past year, the company having made large shipments to Central and South America, Japan, and the Strait Settlements. Indications for further increase in these directions are most favorable.

THE PEERLESS ELECTRIC COMPANY, Warren, Ohio, states that among recent orders booked are the following: From the Empire Plow Company, of Cleveland, Ohio, for a 100-kw. generator and motors aggregating 110 h.p., for individual drive. The Kalamazoo, Mich., Railway Supply Company is installing 20 h.p. and 35 h.p. Peerless motors. The Southard Novelty Company, of Columbus, Ohio, has completed a model equipment consisting of a 25-kw. generator and thirteen Peerless motors. Boston, Mass., University is putting in two Peerless motors for laboratory duty, duplicating an equipment some time ago furnished the Massachusetts Institute of Technology. Printing press individual drives have recently been supplied to the United States Indian Training School at Carlisle, Pa., the Solvay Process Company, Solvay, N. Y., and the Glessner Medicine Company, Findlay, Ohio. An equipment that is attracting considerable attention is at the South Sharon, Pa., Steel Works of the Carnegie Co., where one hundred Peerless motors are being used on the conveyor system for handling steel from the rolls. The installation was designed by the Peerless Electric Company's engineers.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY has closed contracts with the Nelson Morris Company for nineteen Type CCL induction motors varying in sizes from 5 to 50 h.p. and totaling 410 h.p., and with the Decatur Car Wheel & Manufacturing Company, Birmingham, Ala., for eight motors of the same type. These are the latest design of induction motors which have been built by this company and have only recently been placed on the market. The Illinois Steel Company has also ordered eighty direct-current motors having an aggregate capacity of 3920 h.p. These motors are of the railway type and range from 30 to 75 h.p. The Hawaiian Electric Company, of Honolulu, has contracted for two 1200-kw., three-phase, 2200-volt, engine-type generators, two 125-kw. exciters, and seven 500-kw., oil-insulated, self-cooling transformers. The Rumford Falls Power Company, of Rumford Falls, Me., has ordered one 550-kw. and one 800-kw., alternating-current generator, which will be direct-connected to water wheels. The order from the latter company also includes two 450-h.p. variable-speed induction motors and 120 Type OD transformers for use on the distributing lines.

CENTRAL STATION NEWS

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

ALABAMA.

ENSLEY.—The City Council has defeated the resolution to call an election to vote on issuing bonds for a municipal electric light plant.

CITRONELLE.—The Business Men's Association of Citronelle, will consider propositions for the establishment of an electric light plant. C. W. Thomas is secretary of the association. The town has a population of 1,500.

OPELIKA.—It is reported that the capacity of the Opelika electric plant is to be increased three-fold to furnish power for the railway, and light and power to Opelika and Auburn. Capital, $300,000. It is stated that work of construction is to be commenced within thirty days.

ELBA.—The Pea River Power Company has been incorporated with a capital stock of $100,000. The company proposes to light the city with electricity and to supply current for commercial lighting, heating and power. The incorporators are Charles Henderson, H. D. Boyd, J. M. Garrett, B. W. Page, Y. W. Rainer and W. B. Perdue. The headquarters of the company will be in this city, but the plant, it is understood, will be located at some distance from here.

ARIZONA.

DOUGLAS.—The Douglas Improvement Company is reported to have decided to double the capacity of its water system and improve the electric lighting service.

ARKANSAS.

LUXORA.—Wm. Wood, of the Luxora Water & Light Company, writes that it is proposed to construct an electric light plant at a cost of $3000.

DARDANELLE.—It is reported that bonds have been sold by the city for an electric light plant and the building of the plant is to be started immediately.

JONESBORO—It is reported that the Jonesboro Improvement District will expend about $220,000 for the purchase of the water and lighting plants, and the construction of a sewerage system.

CAMDEN.—George Wilson, chief electrician of the Little Rock Railway & Electric Company, was in Camden recently installing a new 90-kw. alternator and a 15-kw. transformer, thereby producing 30 per cent more capacity than the old plant. The Camden company recently sold out to J. A. Trawick and J. A. Van Etten, of Little Rock, and George D. Rosenthal and William Hand, of St. Louis.

CALIFORNIA.

QUINCY.—The electric plant of H. C. Flournoy has been sold to Miss A. L. Gasner of this place.

OROVILLE.—The Oroville Light & Power Company is soon to commence work on a large power plant near Prentz.

UKIAH.—It is stated that bids will be received until Sept. 6 for a franchise to maintain certain electric transmission lines along public highways.

GILROY.—The citizens have voted in favor of issuing $51,000 bonds for the purpose of constructing sewers, providing water and electric lights and completing the City Hall.

ANAHEIM.—C. A. Copeland, of Los Angeles, has submitted to Council a report on improving and enlarging the water works and electric light plant. He estimates the cost at $40,000.

LOS ANGELES.—The details of the contracts let by the Edison Electric Company of Los Angeles for the equipment of Kern River No. 1 power plant include four 5,000-kw. three-phase generators, two exciters and step-up transformers for 75,00 volts and four Allis-Chalmers waterwheels, which are to be direct-connected.

MARYSVILLE.—The Marysville & Nevada Power & Water Company, it is reported, is having surveys made under the direction of Engr. Waggoner for a canal system that will irrigate many thousands of acres of land in Yuba County. At the point where the survey crosses Dry Creek, it is stated, that provision is being made for the installation of an electric light plant.

COLORADO.

DENVER.—It is stated that the Denver Gas & Electric Co. will expend about $150,000 in improvements. The company has been awarded a 5-year contract for lighting the streets with 50-c.p. lights.

CONNECTICUT.

STAFFORD SPRINGS.—Judge Reed has extended the time four months for the local electric light company to continue to do business under the receiver.

PLAINFIELD.—An electric power plant is to be built at the Quinebaug River, near the Canterbury bridge. The water power there has been examined by some railroad men who are favorably impressed towards utilizing it for trolley purposes.

DELAWARE.

DOVER.—The Harrington Light, Heat & Power Company has been incorporated with a capital of $25,000. The incorporators are Harrington and Philadelphia men.

FLORIDA.

MARIANNA.—The citizens have voted to issue $9,000 bonds to construct an electric light plant.

LAKELAND.—The Council has under consideration the question of increasing the capacity of the electric light plant, also putting same on duplicate basis, figuring on two 150-h.p. compound engines, a 100-kw. generator and a 150-h.p. boiler. W. B. Clay, Supt. Electric Light plant.

ST. AUGUSTINE.—The citizens have voted for a municipal electric light plant and extension of water works. A franchise for electric lighting was also granted to T. R. Osmond for the St. Johns Light & Power Company, which proposes to manufacture gas, electricity or other illuminants for light and power and to construct and operate electric railways.

JACKSONVILLE.—The following are the bids opened by the Board of Trustees for furnishing a motor generator set of about 300-kw. capacity; (*a*) Synchronous motor set; (*b*) alternate bid for induction motor set: Crocker-Wheeler Co., Ampere, N. J., *a* $6,925, *b* $7,600; General Electric Co., Schenectady, N. Y., *a* $6,073, *b* $5,430; Electric Machine Co.; Minneapolis, Minn., *b* $7,035; Ft. Wayne Electric Co., Ft. Wayne, Ind., *a* $5,623, *b* $5,331; Allis-Chalmers Co., Cincinnati, O., *a* $7,713; Westinghouse Electric Co., Pittsburg, Pa., *a* $6,671, *b* $5,380, and National Electric Co., Milwaukee, Wis., *a* $6,700.

GEORGIA.

COCHRAN.—This town has voted for $17,000 5 per cent. bonds for water and electric lights.

LAGRANGE.—Ludwig & Co., of Atlanta, have secured the contract to construct the municipal electric light plant for Lagrange.

CORDELIA.—John P. Emerson, an electrical engineer, is reported to be preparing plans for an electric light system in Cordelia and other places.

MONROE.—The Electric Supply Company, of Savannah, has secured the contract to construct the municipal electric light plant for about $20,000.

WINDER.—It is proposed to install at the city electric light plant a 30-kw. alternating-current generator, switchboard, etc. D. W. Robertson is superintendent.

THOMASVILLE.—The City Council is stated to have granted the Municipal Investment Company, of Chicago, Ill., and Columbus, Ga., a franchise for an electric light plant.

FORT GAINES.—Eugene E. Gaddis, Secy. Interstate Water Works & Construction Company, of Washington, D. C., which recently secured a franchise for water works and an electric light plant at Fort Gaines, writes that this company expects shortly to take bids for the construction of several water works and electric light plants. Nothing definite has yet been done.

ILLINOIS.

FREEBURG.—The Village Board, it is reported, has decided to erect a $10,000 municipal lighting plant.

SHAWNEETOWN.—A. M. Searles has received a franchise for water works and an electric light plant.

CLAYTON.—It is proposed to purchase at once a 60-kw. alternator for the municipal electric plant. I. M. Brown is superintendent.

OTTAWA.—The Ottawa Power Company has been incorporated with a capital of $5,000. Jas. A. Sheldon is one of the incorporators.

ALPHA.—The Tri-County Light & Power Company expects to extend its lines to North Henderson and Viola. W. I. Taze is manager.

BLOOMINGTON.—The Peoples Gas, Electric & Heating Company will probably rebuild its plant in the course of a year. J. N. Moncrieff is superintendent.

ROODHOUSE.—The Roodhouse Light, Heat & Power Company has been incorporated, with a capital of $30,000. Edmund C. Kreider, Sr., is one of the incorporators.

LOAMI.—The Sangamon County Light, Heating & Power Company has secured a 25-year franchise in this village. The village also contracted for five 2,000-c.p. arc lights for five years.

DIVERNON.—D. H. Garvey, Village Clerk, writes that the contract for constructing an electric light plant has been awarded to the Fort Wayne Electric Company, St. Louis, Mo., for $7,672.

WAUKEGAN.—The City Council has adopted a resolution authorizing H. Thacker, City Clerk, to procure bids for furnishing 200 5-ampere arc lamps for street lighting on a 3, 5 or 10-year contract.

EDWARDSVILLE.—The City Council has granted a franchise to the Slocum & Siegel Gas Company for erecting, maintaining and operating a gas and electric plant for the purpose of furnishing power, light and heat.

CHICAGO.—Shepley, Rutan & Coolidge are preparing plans for the enlargement of the Hyde Park plant of the Commonwealth Electric Company. The estimated cost of the work is $150,000. The new building will be of brick, stone and steel, and two new 1,000-kw. motor-generator sets will be installed at present, room being provided for six sets. The new apparatus being installed will change the frequency from 25 to 60 cycles.

LOCKPORT.—Bids will be received until Oct. 11 by the Board of Trustees, Sanitary District, Chicago (S. D. Griffin, Clerk) for furnishing electrical apparatus and materials and for installing same in the power house of the Sanitary District of Chicago, near Lockport, and transmission line along the right of way of said District of Chicago. Bids may be submitted as a whole or separately on the following: Main switchboard and instruments; transfer boards, oil circuit-breaker switches and knife switches; remote controlled rheostats for generators; bus bars and bus bar and circuit compartments; conduits, service wiring, transformer and generator connections; transformers and lightning arresters; transmission line towers or poles; erecting towers or poles; copper and aluminum conductors; erection of cable; high tension insulators; electric traveling crane. Cost reported to be $160,000.

INDIANA.

FRANKLIN.—The Franklin Water, Light & Power Company's building has been destroyed by fire.

DANA.—The citizens at a special election voted to install a modern electric light plant in that place.

MATHEWS.—Charles Sampson has been granted a franchise to install an electric light plant in Mathews.

NORTH MANCHESTER.—Dr. D. Ginther and others are reported interested in the construction of an electric light plant at this place.

VALPARAISO.—The Valparaiso Light & Fuel Company has sold its gas and electric light plant to Charles H. Geist, of Chicago, for $60,000.

FRANKFORT.—It is proposed to add a 120-kw., alternating-current generator to the city electric light plant. J. T. Small is superintendent.

NEWPORT.—The Town Trustees are reported to have granted E. E. Sayler, of Saybrook, Ill., a franchise to install an electric light plant at Newport.

WORTHINGTON.—The Indiana Water & Light Company contemplates installing a new arc light system, the adoption of meters and the extension of lines.

NORTH VERNON.—It is proposed to install at the city electric light plant before the fall, an additional 150-kw. unit and boiler. A. B. Berkshire is superintendent.

INDIANAPOLIS.—Officials of the several roads centering at this city have decided on building a power, heat and lighting plant southeast of the Union Station train sheds, to cost $50,000.

MUNCIE.—Among the improvements contemplated by this city is the rewiring of the city electric lighting system and the purchase of 100-ft. stacks. Harry L. McCullough is superintendent.

NOBLESVILLE.—The S. M. Smith Company, owner of the electric light plant, proposes to change from the open arc to enclosed direct-current, 6.6 ampere lamps and rebuild the pole lines. O. N. Eiler is manager.

COLUMBUS.—The Columbus Street Railway & Light Company contemplates constructing a power house, making extensions to the street railway and electric light systems and the addition of a heating plant. R. F. Gottschalk is president.

GREENFIELD.—The City Council has decided to repair the electric l[illegible] plant. The proposition to take individuals [illegible] partnership with the city was not received favorably. Neither was it thought to be advisable to combine the electric and water plants.

JASONVILLE.—The Jasonville Electric Company has been incorporated with a capital stock of $9,000 by David W. Wetnight, H. L. Hyatt and H. L. Hannah, who are directors. The company will receive bids for the construction of an electric light plant.

BRAZIL.—The Brazil Electric Company's new power house on West Main Street, which was recently put in operation, is a model and up-to-date plant. The machinery now installed consists of a 250-kw. Westinghouse generator driven by a four-valve Fleming engine. The two other generators located at the power house at the brewery which have been furnishing current since the company began business, will be moved at once to the new power house and put in position on the foundations which have already been completed for them. The company will then be equipped with the latest approved machinery and will be in a position to furnish excellent service.

PORTLAND.—The City Council of this city has reduced the rate for electric light current to a point lower than that of any other paying plant in Indiana. The light committee and Superintendent Baily reported that it had been found possible to grant a reduction. The new scale is: For 10 kilowatts, 8 cents per kilowatt; 30 kilowatts, 7 cents, and 60 kilowatts or more, 6 cents. The minimum charge is reduced from 75 to 60 cents, the city furnishing the meter. The old rate ran from 9 cents to 7 cents and each rate was stationary to such an extent as to make the reduction equal to 30 per cent. The committee says a sufficient profit is left to pay all expenses of the electric light department, including salaries, and give the city its seventy street arc lights free. When the city plant was under private ownership these seventy arc lights cost $80 each per year.

INDIANAPOLIS.—According to recent statistics gathered by the State Statistician for the year ending June 30, 1905, 32 cities of the 84 in Indiana owned their electric light plants, and 52 cities were lighted by contract with private corporations or parties. The entire cost of lighting for all the cities was $890,666.44. The cost of the 32 cities with municipal plants was $320,327.61, and for the 52 cities lighted by private contract $570,388.83. The receipts from this source in the 32 cities maintaining municipal plants was $345,961.46, leaving an overplus of $23,633.85 for these cities. The average cost per city of those owning plants was $10,010.23, and of those renting the lights was 10,960.15. The average cost of the latter was $955.92 per city greater than the former. Although the number of lights of each are not given, and for this reason no true basis can be had, yet the advocates of municipal ownership are claiming a victory over private management as to cost to the consumer. The total receipts of all the cities of the State maintaining electric light plants during 1905 was $10,022,550.48.

INDIAN TERRITORY.

BARTLESVILLE.—The Bartlesville Electric Light & Power Company has been incorporated.

COWETA.—The Coweta Rolling Mill, Light & Power Company has been organized with a capital stock of $15,000.

CLAREMORE.—The Claremore Light & Power Company has been incorporated, with a capital of $25,000. Incorporators: J. M. Bayless, F. A. Neilson, W. W. Bryan and others.

CHICKASHA.—The Chickasha Light & Power Company (C. E. Ross, Mgr.) proposes installing a 250-h.p. Corliss engine, a 150-h.p. boiler, brick building, and repairs and additions to its lines.

IOWA.

ELDORA.—The Eldora Electric Light Company will make extensive improvements to its plant.

SUMNER.—L. L. Stewart is stated to have secured a franchise for an electric light and power plant.

DENISON.—The Denison Electric Light & Power Company contemplates installing a 50 or 60-kw. unit and a boiler.

PANORA.—The electric light company has under consideration the construction of an electric light plant on the river at Rees' Mill.

BEDFORD.—The Bedford Light, Heat & Power Company proposes to install two new 60-cycle alternating-current generators, one of 40-kw. and the other 100-kw. capacity. M. L. Burt is president.

MADRID.—The Madrid Electric Light & Power Company wants estimates on installing storage batteries of sufficient capacity to carry lights after 12 o'clock and also carry a day current. W. Zenar is chief engineer.

ALBIA.—The Albia Electric Light & Power Company has just started a day circuit, and is in the market for small direct-current motors of ½ to 25 horse-power, 110 and 220 volts. A. R. Jackson is the purchasing agent.

OXFORD MILLS.—The Zinn Electric Light & Power Company is being incorporated by H. A. Zinn, F. E. Zinn and A. L. Zinn, with a capital of $35,000. The company purposes buying the water power and rights, also the mill property of J. R. Zinn & Son at this place.

KEOKUK.—The Keokuk & Hamilton Water Power Company proposes to develop electric power at the foot of Des Moines Rapids and transmit it to cities in the states of Iowa, Illinois and Missouri. It is proposed to develop a minimum of 60,000 horse-power. The estimated cost of the proposed work is $6,000,000. John N. Irwin, of Keokuk, is president; R. R. Wallace, of Hamilton, Ill., is secretary, and Lyman E. Cooley, of Chicago, Ill., is consulting engineer.

ANAMOSA.—The Anamosa Electric Light & Power Company is being incorporated by H. A. and F. E. Zinn, of Oxford Mills, this state, and Park Chamberlain, of this city, with a capital of $35,000. The company will take over the plant, water power and mill property of the Metcalf Light & Power Company and will overhaul the plant and add new boilers, generators and transformers.

KANSAS.

OTTAWA.—F. A. Sharpe, of Lawrence, has petitioned for a franchise for an electric light plant.

HAYS CITY.—The Hays City Electric Light & Power Company proposes to install a 65-kw., 1,100-volt alternator.

ALMA.—A company has been organized by local men at Alma; they are installing a small light plant, alternating system.

GARDEN CITY.—The Garden City Electric Company will soon add to its equipment a 75-kw. dynamo and a 100-h.p. Corliss engine.

LINCOLN.—A committee has been appointed, including A. Marshall, J. Albert Smith and others, to investigate and report on the question of constructing water works and an electric light plant.

WICHITA.—The Wichita Railroad & Light Company is stated to have secured the contract for furnishing 271 arc lights for five years at an annual cost of $14,454. Each light will be run with a power of 460 watts and be lighted at dusk and burn until 1 o'clock. The company will furnish additional lights at $66 per light per year.

KENTUCKY.

LEWISPORT.—Jesse Emmick is interested in the construction of an electric light plant.

PIKEVILLE.—The Pikeville Electric Light Company will install a 100-kw., 250-volt, direct-connected generator.

SOMERSET.—Bids will be received by T. R. Griffin, Mayor, and the Board of Council, for a twenty-year electric light franchise.

RUSSELL.—E. E. Fullerton, of Greenup, writes that bids will be received for the construction of an electric light plant at Russell; probable cost, $5,000.

NEWPORT.—The question of issuing $50,000 of bonds for the purpose of erecting a municipal electric light plant will be submitted to a vote of the people of Newport at the next election. It requires a two-thirds vote to carry.

MIDDLESBOROUGH.—The Middlesborough Electric Light, Heat & Power Company may move its plant to the water works; if not, it is proposed to install a dynamo at the present station and a motor at the water works station. The company would like information about cost of iron poles and undergrund conduits. Address W. M. Todd, manager.

STOUGHTON.—Bids will be received by the Electric Light Committee for a 100-kw. belted three-phase alternator; 100-kw. steam turbo-alternator; two switchboards with instruments; 75-light constant-current transformer; 50 series alternating-current enclosed-arc lamps; water-wheel governor for two 100-h.p. wheels; a 150-h.p. boiler and a boiler feed pump and heater.

LOUISIANA.

WILSON.—The question of constructing water works and an electric light plant is under consideration here.

MARKSVILLE.—Sealed bids for the construction of a system of water works and electric light for the town of Marksville have been received.

ALGIERS.—The Orleans Levee Board has granted permission to the New Orleans Railways Company (A. L. Black, Electrical Engr., 317 Baronne St., New Orleans) to lay a number of cables across the river for the purpose of furnishing the necessary lights and electric wires to Algiers.

ARCADIA.—A company has been organized here with a capital of $5,000 with J. L. Dalton as president and M. L. Tooke as secretary and treasurer. The company has bought the Dalton-Lord electric light plant located here, and it is reported will make considerable improvements and additions.

MAINE.

WATERVILLE.—The Messalonskee Electric Company is reported to have in contemplation the development of another water power. W. Wyman, Mgr., Waterville.

OAKLAND.—The Messalonskee Electric Company, whose incorporation was recently noted, proposes to construct an electric light plant at Oakland to cost $125,000. L. Metcalf, 14 Beacon St., Boston, Mass., is the engineer.

FORT FAIRFIELD.—B. D. Whitney, of Fort Fairfield, engineer of the Maine & New Brunswick Power Company, writes that survey is now being made for the proposed power plant of this company on Aroostook River. A. R. Gould, of Presque Isle, Me., is one of the parties interested.

AUGUSTA.—The Southern Power & Improvement Company has been organized at Augusta, for the purpose of manufacturing, generating, buying and selling electric energy for lighting, heating and power, etc., with $10,000 capital stock, of which nothing is paid in. President, I. E. Fairbanks, of Augusta.

LEWISTON.—The Alfred Light & Power Company, which is controlled by the Atlantic Shore line, has taken over the Linscott and Ester water privileges, which were purchased by Bodwell Brothers some time ago. In developing these privileges they will make one privilege at the Ester dam and that will give them a water power capable of developing 800 horse-power.

OLDTOWN.—The Milford Construction Company has closed a contract with Jas. B. Mullen, of Bangor, Me., to construct a dam and powerhouse. The plant consists of a concrete dam about 1,000 feet long across Penobscot River at Oldtown giving about 25 feet head and a powerhouse containing twelve 1,000-h.p. generators, direct-connected to water wheels. The power produced by the new plant will be transmitted to Bangor, fifteen miles away.

MARYLAND.

LONACONING.—The Lonaconing Electric Light & Power Company expects to install a 90-kw. dynamo. Wm. Atkinson is manager and purchasing agent.

ANNAPOLIS.—Andrew Westervelt, Secretary Maryland Heat, Power & Light Company, writes that about $40,000 will be expended in improvements. Howard E. Crook, president.

BALTIMORE.—The United Electric Light & Power Company is reported to have awarded contracts for the equipment of its power station at Westport as follows: Ten boilers of 700 h.p. each to the Babcock & Wilcox Boiler Company, of New York, four engines of 3,000 h.p. each, and overload capacity of 4,500 h.p., to the McIntosh & Seymour Company, of Auburn, N. Y., and four generators of 2,000-kw. capacity each and overload capacity of 50 per cent, to the General Electric Company, of Schenectady, N. Y. The building, contract for which will soon be let, will be one story, 255 x 110 feet. Between the water front and the building will be extensive coal-storage yards, in addition to the bunker storage provided in the building. A gantry crane 275 feet long will span the distance between the building and the water front to pick up and carry coal.

MASSACHUSETTS.

HOLYOKE.—About $9,500 will be spent on improvements for the municipal electric light plant.

GLOUCESTER.—The Gloucester Electric Company proposes to add to its equipment a 500-kw. Curtis steam turbine.

QUINCY.—The Quincy Electric Light Company may issue $50,000 stock at par, $100, to pay for additions to plant made prior to July 1.

BRIDGEWATER.—The property of the Bridgewater Electric Light Company has changed hands recently, the new owner being Lawrence Cleare of this town.

PLYMOUTH.—At the annual meeting of the Plymouth Electric Light Company the following officers were elected: James N. McCoy, president; Frank C. Calley, treasurer; George H. Adams, clerk; James N. McCoy, Fred P. Weeks, Warren G. Chase, George H. Adams and Frank C. Calley, directors.

HUNTINGTON.—The gas and electric light commissioners have issued an order approving the issue of $5,000 of new capital stock by the Huntington Electric Company for the purpose of purchasing the electric lighting plant and business in Huntington formerly owned and operated by ex-Representative Henry E. Stanton.

FALL RIVER.—The Fall River Electric Light Company is to issue $250,000 capital stock, to be offered to stockholders at $130 a share. The proceeds of 190 shares must be used for the cancellation of a like amount of floating debt on account of the purchase of land, and proceeds of the remaining 2,310 shares are to be used in payment of additions made subsequent to May 1.

NEW BOSTON.—Engineer H. F. Keith, of Mt. Washington, Mass., with a corps of engineers, is reported to have arrived at New Boston, to make surveys and ascertain the cost of an electric power plant, a charter for which is reported to have been granted by the recent Connecticut Legislature. The company proposes to sell and transmit electric power to various cities in Massachusetts and Connecticut.

LEOMINSTER.—The Heat, Light & Power Corporation of Boston has made a deal for the purchase of the Leominster Electric Light & Power Company. The ratification of the deal and the transfer of stock will follow the annual meeting of the trustees of the Leominster company. The price agreed upon is about par for the capital stock of the Leominster company, which is $50,000. The Heat, Light & Power Corporation already operates several plants in Worcester county, besides others elsewhere.

CAMBRIDGE.—The Cambridge Electric Light Company has completed arrangements for a reduction in its tariff to customers to take effect from and after October 1, 1905. The basic rate for incandescent house lighting will be changed from 16 2-3 cents to 15 cents per kilowatt hour. The old rate of 16 2-3 cents allowed a reduction of 15 per cent. for prompt payment, making the rate 14.17 cents net. The new rate allows a reduction of 10 per cent., making the net price 13½ cents, a saving of .67 cent. In addition the company will supply free renewals of lamps, so that the total reduction to customers will be about 10 per cent. The reduced rates will also apply to small stores and offices.

MICHIGAN.

ADRIAN.—The Citizens' Light & Power Company contemplates installing a 500-h.p. turbine and boiler outfit.

ALPENA.—Richard Collins has been awarded the contract for the power house of the new water works, at $16,055.

L'ANSE.—The Superior Construction Company, of Houghton, is reported to be preparing plans for a municipal lighting plant for L'Anse.

ROSE CITY.—Frank G. Bell and James Monaghan have made application to the City Council for a franchise for an electric light plant.

SAGINAW.—The Bartlett Illuminating Company is stated to have secured the contract for lighting the city for five years, at $60 per light per year.

MARSHALL.—P. A. Mumaw, Village Recorder, writes that probably nothing will be done this year toward improving the water works and electric light plant.

MASON.—A new boiler, engine, alternating-current dynamo, switchboard, etc., are needed for the municipal electric light plant. R. E. Darling is superintendent.

GRAND RAPIDS.—The city authorities have been requested to open negotiations for the lease of the municipal electric lighting plant to a syndicate of eastern capitalists.

HASTINGS.—The Hastings Gas Company has sold its plant to the Thornapple Electric Company, which will hereafter be known as Thornapple Gas & Electric Company.

ESCANABA.—The Board of Public Works is reported to have petitioned Council for an appropriation of $14,000 to purchase additional machinery for the electric light plant.

PONTIAC.—The Pontiac council has not yet settled the street lighting proposition. The Pontiac Standard Lighting Company, the Pontiac Light Company and the Clinton River Power Company are bidders for the contract.

KINGSLEY.—The village has let the contract for furnishing electric lights to A. Gibbs, of Mayfield, Mich. The contract calls for five arc lights and more to be furnished as needed. Mr. Gibbs will also furnish commercial lighting.

KALAMAZOO.—The old factory buildings of the Kalamazoo Electric Company have been purchased by the Kievet & Lounsberry Company, manufacturer of engines and boilers. The plant will be remodeled and put in shape for the new company in a short time.

HOUGHTON—The Houghton County Electric Light Company has elected the following directors: Henry G. Bradlee, James R. Dee, Waldo E. Forbes, Henry R. Hayes, William L. Putnam, Russell Robb, Charles A. Stone, Edwin S. Webster and Charles D. Wyman.

HART.—The Pere Marquette Power Light Company, it is stated, has been granted a 10-year franchise by the Council to furnish current to the village. The company will dam Ruby Creek, build a turbine plant and furnish light and power to Pentwater, Hart and Shelby.

BIG RAPIDS.—The Michigan Heater Company, which is rebuilding the burnt portion of its plant for the Hanchett Sewage Works, is also figuring on generating electric power to supply its own needs, the needs of the Hanchett Sewage Works and also to give the city a day current.

DETROIT.—The Public Lighting Commission of Detroit has let the contract for a new turbine engine, with a capacity for 4,000 arc lamps, to the Westinghouse Machine Company of East Pittsburg, Pa. Of the bids put in for this unit several weeks ago, the Westinghouse was the lowest at $61,283.

STANDISH.—The Rifle River Power Company has petitioned the Board of Supervisors of Arenac County, at Standish, for permission to construct three dams across Rifle River, the power developed to be used for electrical purposes. Geo. D. Silsby, President; Frank F. Kleinfield, Secretary, and H. E. Terry, Engineer, all of Saginaw.

PONTIAC.—The Pontiac Savings Bank and the Citizens' Savings Bank, of Holly, have taken possession of the Holly Milling Company at Holly. This also includes the Holly Electric Light & Power Company. C. H. S. Poole, president and majority stockholder of the company, it is said, is indebted to the banks in the sum of $15,000.

JACKSON.—The Commonwealth Electric Company has commenced the erection of a big dam in the Kalamazoo River, near Ceresco, five miles west of this city. It is the purpose of the company to furnish more direct power for the Jackson & Battle Creek Traction Company, and it is thought that 1,000 horse-power can be obtained from the dam.

CASS CITY.—Surveys are now being made for the construction of a dam for the municipal electric light plant, about four miles southwest of Cass City, on Cass River. If the report is satisfactory the water power plant will be built next spring, for which a new equipment of dynamos, motors and pumps will be needed. Wm. N. Strube is superintendent and chief engineer.

MONROE.—The City Council recently passed a resolution for the sale of the municipal lighting plant to the General Construction Company, Ltd., for $25,000, including a 10-year contract and franchise, lights at $56 per year. Both the sale and contract will have to be ratified by the people at a special election. Geo. T. Wolf, of Three Rivers, is one of the stockholders of the company.

BENTON HARBOR.—The power at the Buchanan village dam, which is controlled by Charles A. Chapin, is to be transferred in part to Benton Harbor and St. Joseph. Another dam will be constructed at King's landing, where Chapin has a large site. A recent decision of the Supreme Court gave Chapin the right to sell the power where he desired, despite the exclusive contract with Buchanan.

ANN ARBOR.—The Washtenaw Light & Pow-

er Company, of this city is to be united with the light and power system of Detroit, and within a few months a feed wire will be run from the Geddes plant to the county line to connect with a feed wire from Delray. The companies concerned are all controlled by the North America syndicate, which is preparing to develop extensively the power of the Huron River.

MUSKEGON.—The Shaw Electric Crane Company is planning to drive all of the machinery of its great shops at Muskegon Heights by electric current, to be furnished by the Grand Rapids-Muskegon Water Power Electric Company. The machinery is now driven electrically from the Shaw Company's own plant. A new 400-h.p. rotary converter will be put in by the Shaw Company.

DETROIT.—C. Hayward Murphy, of the Murphy Power Company, writes that it is proposed to construct a power house for the generation of electricity and steam; also a cold-storage warehouse. J. F. Lewis is Superintendent and Engineer.

The Public Lighting Commission (H. P. Hetherton, President) will within one year install one 2,000-kw. unit.

CLARE.—The village has renewed its contract with the Clare Electric Company for lighting the streets for five years at $4.90 per month for each light. Senator Doherty desired a contract to the end of his franchise nine years hence and offered light for $4.75 a month if the longer contract was granted. The city expects to be in shape to take over the lighting plant at the end of the five-year contract. The rate established will make the cost of lighting the streets $800 a year.

GRAND RAPIDS.—The Cascade Electric Company, which has acquired flowage rights on the Thornapple River, is seeking a franchise in the city to furnish commercial lighting and power. The proposed franchise prohibits the company from charging more than 15 cents per kilowatt-hour for lighting and 4 cents per horse-power-hour for power, and forbids the company disposing of the franchise to a competitor. The management of the enterprise is vested in Frederick C. Miller, and associated with him are Ernest A. Stowe, Stephen Sears, Robert W. Irwin, A. Hompe, C. C. Follmer, Henry Idema, Walter C. Winchester and Guy W. Rouse, all Grand Rapids men.

MINNESOTA.

PINE CITY.—The Pine City Milling & Electric Company has contracted for a new dynamo of 750-light capacity.

STARBUCK.—Mr. A. H. Dreyer, superintendent of the village lighting system, reports the addition of a new 30-kw. dynamo and a 50-h.p. engine.

MARSHALL.—It is proposed during the coming year to remodel the entire equipment of the municipal electrical light plant. E. Simmons is superintendent.

BROWNS VALLEY.—E. R. Marshall, City Recorder, writes that a committee has been appointed to investigate the question of constructing an electric light plant.

RUSHFORD.—The Rushford Power Company has been granted a 30-year franchise for an electric light system here. The secretary writes that the proposed work contemplated by this company will cost about $18,000. D. J. Tew, C. H. Grier, J. Webster and others are among the parties interested.

MISSISSIPPI.

HOUSTON.—Bids will be received until Sept. 1 by J. M. Griffin for $13,500 water and light bonds.

PONTOTOC.—The citizens are reported to have voted to issue bonds for the construction of an electric light plant.

SARDIS.—The Panola Electric Light & Power Company expects to put in a series arc light circuit for street lighting about January 1 next.

GRENADA. —The improvements contemplated at the municipal electric light and water plant are reported to include the purchase of two new generators. B. C. Adams, Mayor.

PHILADELPHIA.—The Philadelphia Compress, Electric Light & Ice Manufacturing Company has been incorporated with a capital stock of $30,000 by A. M. Boyd and others.

GLOSTER.—This city is reported to have in contemplation the installing of duplicate dynamos and engine within twelve months at the city electric light plant. Howard E. Pigford, Mgr.

HAZLEHURST.—The citizens are reported to have voted to issue $10,000 bonds, to be used for enlarging the school grounds, adding more water mains, and increasing the lighting facilities.

UNION.—The Gulf States Investment Company has been incorporated with $200,000 capital stock, by S. M. Jones, F. L. Riley and R. W. Jones, to operate lighting plants, water works, sewerage systems, etc.

MISSOURI.

SKIDMORE.—The question of lighting this place by electricity is reported under consideration.

CAPE GIRARDEAU.—The Cape Girardeau Water Works & Electric Light Company (Thos. Fox, Supt.) will construct new gas plant this fall.

KANSAS CITY.—The Kansas City Electric Light Company (R. E. Richardson, Mgr.), it is reported, will put in new conduits.

JOPLIN.—The Spring River Power Company proposes to construct a new power plant. The Arnold Company, of Chicago, Ill., is the engineer.

COLUMBIA.—John S. Bicknell, City Clerk, writes that it was voted August 8 to issue $10,000 water and electric light bonds and $10,000 public sewer bonds.

ST. LOUIS.—The Board of Public Improvements is considering bids for furnishing electricity at the city institutions for one year from September 1. During the present year the expense has been $22,000. The contract includes power for all of the fire engine houses and other city buildings.

CARONDELET.—Henry C. Scott, president of the Edison Electric Company of Carondelet, St. Louis, has entered a protest with the Board of Public Improvement of St. Louis, alleging that the Union Electric Light & Power Company has violated its agreement with the city of St. Louis by refusing to allow the Carondelet company to string wires on the Union poles in South and West St. Louis. No room on the poles is given as the basis for refusal, but Mr. Scott offers to buy the poles and rent them to the Union company at the price stipulated by the city.

MONTANA.

LIVINGSTON.—Ground has been broken for the new power plant which the Livingston Water-power Company will erect on the Yellowstone River. The company expects to expend about $200,000.

BUTTE.—Samuel T. Hauser, of Helena, former Governor of Montana, is interested in the construction of a second dam across the Missouri River. It is proposed to transmit the power to Anaconda.

NEBRASKA.

NELSON.—The Nelson Electric Light Company has its power house enclosed, and will soon begin installing the machinery.

FALLS CITY.—This city has voted an issue of $36,000 bonds for public improvements, of which $10,000 are to be used for constructing an electric light plant.

YORK.—The York Electric Light & Power Company and the York Gas Company have effected a consolidation and will be known as the York Electric Light, Gas & Power Company. C. A. Haas of Omaha has been elected president and J. A. Peffer manager.

NEVADA.

WINNEMUCCA.—It is reported that the electric light plant has been damaged by fire.

RENO.—A deal for the consolidation of Reno's two electric companies has been pending for some time, but H. C. Cutting, its promoter, has left the city, and it is believed that the project is now off.

NEW HAMPSHIRE.

CONCORD.—The Concord Electric Company has closed its plant at Sewall's Falls for repairs and improvements, and is supplying electricity from its steam plant on Bridge St. and from Garvin's Falls.

NEW JERSEY.

NUTLEY.—The Town Council has granted a four-year contract to the Public Service Corporation for the lighting of the streets of the town at $16 per lamp.

WOODSTOWN.—The Woodstown Ice & Cold Storage Company, which lights this town, proposes to install a larger dynamo and engine. C. F. Moore is manager.

NEWARK.—Wm. J. Lansley, of Englishtown, engineer for the Manalapan Light Company, writes that the cost of the proposed work contemplated by this company is $40,000. The General Electric Company furnishes the generators.

ATLANTIC HIGHLANDS.—At the municipal electric light plant, it is expected to change over to alternating enclosed arcs and the alternating system to 2,000 primary and 60 cycles. A new dynamo and engine will also be installed. F. E. Price is superintendent.

KEARNY.—The Kearny Common Council has discovered that it has no power to issue bonds for a municipal plant, and has instructed its Lighting Committee to make a contract with the Public Service Corporation to light the streets for one year only at the reduced price offered by the company—$97 a year for arc lights and $15 a year for incandescent lights. The reduced offer made by the corporation was for a term of five years, and it is probable that the company will refuse to renew the contract, which expired on August 1, for a year at the reduced prices, and will compel the town to pay $100 a year for arc lights and $16 for incandescents.

NEW MEXICO.

RATON.—The Raton Electric Light & Power Company will install a new boiler, engine and a 150-kw. alternating-current dynamo.

CARLSBAD.—A large power dam has been finished to replace the one destroyed by the storm last fall, and this town is again lighted by electricity.

ROSWELL.—The Roswell Electric Light Company has in contemplation the purchase of an entire new equipment for its power house. J. H. Cook is superintendent.

LAS VEGAS.—The City Council has granted a 50-year franchise for street railways and electric lights to Wm. A. Buddecke, of St. Louis, Mo., owner of the present electric railway system. Extensions to the system to cost $15,000 have already begun.

SILVER CITY.—The City Council has granted a 50-year franchise to Geo. T. Schmelzel and associates for electric lighting purposes in this city. The franchise requires that work be commenced on the installation of the plant within ninety days and that the plant be in operation within six months.

NEW YORK.

LOWVILLE.—The Wetmore Electric Company proposes to install a 500-kw. alternator and a pair of water wheels. L. Wetmore is manager.

CHATHAM.—The electric light plant at Chatham has been sold to the Lindewald Light & Power Company, which is composed of Chatham capitalists.

SALAMANCA.—This village proposes to take over the present water and lighting plants on January 1, 1906, if it is voted to do so at the special election, to be held soon.

LESTERSHIRE.—The Village Board of Trustees has contracted with the Light, Heat & Power Company of Binghamton for five years for the lighting of 30 lights and the main street.

PENN YAN.—The Yates Electric Light & Power Company proposes to rebuild and install two 400-h.p. Victor turbines of the horizontal type, direct-connected to two 150-kw. generators.

NORTH TONAWANDA.—The Tonawanda Power Company, of North Tonawanda, has secured the contract for lighting the city (bids

opened July 1) at $75 per arc light per year for a term of two years.

BUFFALO.—It is reported that the control of the Niagara, Lockport & Ontario Power Company has passed into the hands of a new syndicate of capitalists headed by John J. Albright, of Buffalo, and Mr. Westinghouse, of the Westinghouse Company, and it is stated that extensions are to be made.

LOCKPORT.—The citizens of Lockport are considering a proposition just made by the Albright, Green and Hayes interests of Buffalo, representing the Ontario Power Company, to furnish to the residents of Lockport electric power at $16 per horse-power. They purpose to furnish power in blocks of 100 horsepower at the transmission station on the Ernest farm. The offer is receiving favorable consideration from the business interests of the city.

NORTH CAROLINA.

FAYETTEVILLE. — Electric light bonds amounting to $30,000 have been sold.

ROCKINGHAM.—It is proposed to install a new dynamo at the municipal electric light plant.

SOUTHPORT.—The town of Southport is considering the question of a municipal electric light plant. Several bids for the plant have been received.

RALEIGH.—The Raleigh Electric Company proposes to construct two miles of railway and extend the lighting system. W. J. Andrews is president and manager.

ASHEVILLE.—The Asheville Cotton Mills will soon be operated by electric power from the Weaver power plant on the French Broad River, five miles from Asheville, N. C.

MORGANTON.—W. A. Mauney, of Kings Mountain, and J. M. Torrence, of Morganton, will organize a company to construct an electric light plant and erect a cotton factory.

WINSTON-SALEM.—The Winston-Salem Power Company, with $125,000 capital, has been chartered in North Carolina, and will develop electrical properties, etc. F. H. Fries and others are the incorporators.

GREENSBORO.—The State has authorized the Greensboro Electric Company to increase its capital stock from $250,000 to $500,000, the additional issue being of preferred stock. John Kerr is the president of the company.

CHARLOTTE.—The development of the Catawba River by the Southern Power Company, of Carlotte, will, it is predicted, result in the establishment of many new small industries at points reached by the lines of the new $7,500,000 concern. A total of 75,000 horse-power will be developed.

OHIO.

STRASBURG.—Contracts are being let by the Strasburg Electric Company for doubling the capacity of the plant.

URBANA.—Architect Wm. Miller, of Springfield, is preparing plans for the $5,000 electric lighting plant to be erected here .

HUBBARD.—The incorporated village of Hubbard has issued bonds to the amount of $2660 to be used for additional electrical equipment.

MOUNT VERNON.—Mr. Carl Hoster and Samuel Blumenthal, of the Hoster Brewing Company, intend to install a large electric plant.

TOLEDO.—Frank I. Consaul, chief engineer of the Board of Public Service, estimates the cost of constructing a municipal electric light plant at $470,400.

BELLEFONTAINE.—Seventeen bids were received for the $50,000 electric light improvement bonds at Bellefontaine a few days ago. The highest was $53,672.

ADA.—The Ada Water, Heat & Light Company will require about ten miles of construction material for its extension to Algiers. B. S. Young is secretary and manager.

TOLEDO.—It is reported that the question of holding an election to vote on the issuing of $500,000 bonds for a city lighting plant is under consideration by the City Council.

OBERLIN.—The Oberlin Gas & Electric Light Company, of Oberlin, has been incorporated with a capital of $10,000, by W. B. Whiting, C. F. Brooks, A. J. Sperry and others.

CAREY.—At the village electric light plant it is proposed to add a 75-kw. alternating-current generator and a separate engine for the arc lighting. Harry C. Fink is manager.

GALION.—The Crawford County Gas & Electric Company intends constructing a new power house at a cost of $40,000. S. N. Blake, 15 Westminster St., Providence, R. I., is the president of the company.

PLYMOUTH.—All bids received August 9 for furnishing material and equipment for an electric light and water plant have been rejected and new bids were called for August 28. John T. Bulman is Clerk of the Board of Public Affairs.

READING.—Engineer Geo. Hornung, of Cincinnati, has been engaged to design an entire new plant for Reading to take the place of the present electric light plant. New boilers, engines, generators, street lamps and line work will be required.

COLUMBUS.—The Board of Public Service of Columbus has signed a contract permitting the Columbus Railway & Light Company and the Public Service Company to use the city poles for their lines at 15 cents a contract. The companies were refused the use of the poles some months ago.

ARCANUM.—The following are reported to be the bids opened by the Board of Public Affairs for the construction of water works and an electric light plant: Ryan Construction Company, Indianapolis, Ind., $37,000; Baker, Niswonger & Warner, Arcanum, $34,914; P. H. Porter, Clinton, Ky., $34,816; and the Olds Construction Company, Fort Wayne, Ind., $34,743.

OREGON.

TIPTON.—W. A. McNaughton, of Tipton, it is stated, is arranging for the construction of an electric power plant on Strawberry Creek.

OREGON CITY.—The Portland General Electric Company is reported to be arranging to construct an electric plant on the east side of Willamette River in Oregon City, just below the falls. E. Hippeley, of Portland, is chief engineer.

BAKER CITY.—It is reported that a corps of engineers has been engaged by the Baker Light & Power Company to make surveys from power site on Rock Creek over the ridge into Bourne, and along Cracker Creek to the various mines using power.

PORTLAND.—Jas. Barrett, it is stated, has secured the contract to build a stone power house 50 x 50 and 30 ft. high at the golf links for the Oregon Water Power Company. It is also stated that he has secured the contract to construct a dam and canal or tail race at Cazadero that will require 7000 cubic yards of stone. Both contracts are in connection with the power plant which is being constructed on Clackamas River.

SPRINGFIELD.—An Eastern syndicate which owns electric plants in Spokane, Walla Walla, Salem and other cities, has purchased, according to reports, through its agent, A. Welch, of Salem, the plant of the Lane County Electric Company, at Springfield, which furnishes light for that town and Eugene. The syndicate will take control of the plant in October. It is stated to be the intention of the company to increase the plant to 1000 horse-power, and also that the construction of a system of electric railways in Willamette Valley is contemplated.

PENNSYLVANIA.

WEATHERLY.—The Town Council has decided to construct a new electric light plant.

LOCK HAVEN.—The Electric Light Company has in contemplation the enlargement of its plant on E. Church Street.

COLUMBIA.—The Lancaster County Electric Light & Power Company has decided to construct a power station at Columbia.

KUTZTOWN.—This borough has decided to issue bonds to the amount of about $8000 for the construction of an electric light plant.

HUGHESVILLE.—The Citizens' Electric Light & Power Company is preparing plans for a power plant. John B. Fox is secretary.

WOMELSDORF.—Wm. H. Dechant, of 536 Penn Street, Reading, is preparing plans for the construction of an electric light plant at Womelsdorf.

HYNDMAN. — The Hyndman Electric Light, Heat & Power Company expects to install a larger engine in the near future. N. A. Blair is president.

MAHANOY CITY.—The Mahanoy City Light, Heat & Power Company (Wallace Haldeman, manager) will shortly install a 300-h.p. water-tube boiler.

SOMERSET.—The Somerset Electric Light, Heat & Power Company will add a 300-kw. alternator and a 600-h.p. engine. J. M. Bricker is manager.

SHAMOKIN.—The Shamokin Light, Heat & Power Company expects to replace its present machinery with 600-kw., 60-cycle, 2200-volt, two-phase generators.

LEWISBURG.—Philadelphia capitalists are reported to have purchased the plant of the Lewisburg Gas & Electric Company, and will make some improvements.

TREMONT.—The Tremont & Pine Grove Electric Light & Power Company proposes to extend its system to Pine Grove, a distance of six miles, and to Donaldson, one mile. Geo. Bernd is superintendent.

WILLIAMSPORT.—The Lycoming Electric Company has decided to lay conduits for underground wires in connection with the building of its proposed new power plant on Hepburn Street. Ernest H. Davis is manager.

MILLERSBURG.—Dreibelbis & Company, of Reading, are completing plans for the construction of a 50,000-h.p. plant about a mile north of Millersburg, along the Susquehanna River. The probable cost of the proposed work is $1,500,000.

PHILADELPHIA.—Articles of incorporation have been filed by the Wyoming Gas & Electric Company, with a capital of $150,000, to manufacture and operate gas and electric plants. The incorporators are John McPeak, Wm. F. Eidell and Frank R. Hansell.

READING.—The Reading Illuminating Company, recently incorporated with a capital of $100,000, is making preparations to construct a power plant and install the necessary equipment in the way of wires, cables, conduits, etc. The directors are Gustav Ulbricht, of Brooklyn, N. Y.; Ralph W. Gifford, of New York, N. Y., and Daniel J. Driscoll, of Reading.

M'CALL FERRY.—A mortgage of $10,000,000 has been filed in the Recorder's office at York to secure a bond issue for the McCall Ferry Power Company, a corporation of New York capitalists, who propose building a power plant on the lower Susquehana River near McCall Ferry. The Knickerbocker Trust Company, of New York City, is reported to be named as the trustee for the bondholders.

PITTSBURG.—H. P. Dilworth, of the Dilworth Coal Company, and Chas. Arbuckle Jamison, of Arbuckle & Company, and Stewart Robinson, a realty dealer, are reported to have secured from the U. S. Secretary of War the right to use water flowing over Springdale dam, in the Allegheny River, for power purposes. It is reported that a $400,000 plant will be constructed and power will be furnished for the traction roads in Allegheny Valley and power and light lines will be extended to Tarentum, New Kensington, Oakmont, Creighton, Natrona and Parnassus.

SOUTH CAROLINA.

SUMTER.—The Sumter Electric Light Company has been incorporated with a capital of $200,000.

HARTSVILLE.—There is reported to be some talk of constructing water works, a sewerage system and electric light plant here.

ANDERSON.—The stockholders of the new Hatton's Ford Power Company, at Anderson, recently met and organized by the election of a board of directors, who then chose officers, with

R. S. Ligon, of Anderson, as president. It is estimated that 6000 horse-power is available at the shoals to be developed. The company is capitalized at $150,000 and will offer power for light and manufacturing purposes.

COLUMBIA.—The Columbia Electric Street Railway Light & Power Company is reported to have taken over the Columbia Water Power Company. Among the improvements contemplated is the relaying of rails on Main Street, the entire ovehauling of the electrical appliances and the thorough equipment of the entire plant. Extensive improvements and additions to the power plant are also contemplated. The new officers include Edwin W. Robertson, president, and W. M. Shannon, electrician.

SOUTH DAKOTA.

BELLE FOURCHE.—The franchise for an electric light plant in Belle Fourche has been let to the Belle Fourche Power & Water Company, which is controlled by A. H. Marble, A. A. Moodle and others.

TENNESSEE.

CLARKSVILLE.—The Queen City Electric Light & Power Company proposes installing a 500-kw. Curtis turbine, a 200-kw., three-phase, alternating-current generator, a 250-kw. motor generator set, new switchboard, three water-tube boilers, etc.

BOLIVAR.—The following are the contracts awarded for furnishing material for the water and light plant: Two 60-h.p. return tubular boilers, Southern Engine & Boiler Works, Jackson, Tenn., $1000, and 100-h.p. engine, at $1247; heater and feed pump, to E. G. T. Colles & Company, Chicago, Ill., $186; electrical apparatus, Electric Supply Company, Memphis, Tenn., $2266, and electrical supplies to Ewing-Merkle Company, St. Louis, Mo., $755. Granbery Jackson, Nashville, Tenn., is the engineer.

KNOXVILLE.—The properties of the Knoxville Traction Company and the Knoxville Electric Light & Power Company of Knoxville, have been consolidated into one company, which will be known in the future as the Knoxville Railway & Light Company. This company has been incorporated with a capital stock of $2,000,000, the incorporators being C. H. Harvey, E. E. McMillan, William S. Shields, F. L. Fisher and Leon Fender. Charles H. Harvey, president and general manager of both companies as they had existed heretofore, says that the charter was taken out for the purpose of consolidation of the two interests to expedite the work of improving the lines and service.

TEXAS.

SAN SABA.—The San Saba Light & Ice Company has increased its capital stock from $15,000 to $30,000.

WHITNEY.—Collier Bros. are reported interested in the construction of an electric light plant at Whitney.

DALLAS.—The Egan Electric Company has been incorporated with a capital stock of $15,000 by G. H. Egan, D. L. Gobble and G. G. Wright.

MASON.—The Mason Electric Light Company is now owned by W. Ellebracht, of Mason. It is proposed to install a 70-h.p. engine to take the place of the two engines now in use.

SAN ANTONIO.—The San Antonio Gas & Electric Company proposes installing a 500-kw. alternating-current generator. It is reported that C. A. Zilker, of Bloomington, Ill., is promoting an organization with a capital of $500,000 to build an electric light plant.

DALLAS.—The Dallas Electric Light & Power Company has obtained sanction for the erection of its proposed electric light and power plant, the permit stating that the building will cost $125,000, exclusive of the machinery. It is understood that the mechanical equipment will cost about $350,000. The building will be 75 x 100 feet, of brick and steel. Construction work has been begun.

LLANO.—John W. Maxcy, designing engineer, of Houston, writes in regard to the construction of a power plant on Llano River, and a system of irrigation, that the probable cost of the proposed work is $85,000, and will include masonry dam 900 feet long and 18 feet high, penstocks, two turbines, draft tubes, electric generator, electric transmission line, 200 horsepower to be developed for lights, water works, etc.

UTAH.

PROVO.—The citizens are reported to have voted to issue $91,000 bonds, to be used for the completion of the water works and the construction of a municipal electric light plant.

SALT LAKE CITY.—The County Commissioners are reported to have granted Emil J. Raddatz a franchise to construct and operate an electric transmission system to Bingham Junction and Sandy.

DESERET.—An ordinance has been passed by the Council, according to reports, granting a 50-year franchise to the Utah Light & Railway Company. R. F. Hayward, electrical engineer, Salt Lake City.

VERMONT.

BARNET.—The Pioneer Electric Company will install new water wheels this fall. A. S. Hunt is manager.

ST. JOHNSBURY.—The St. Johnsbury Electric Company intends making improvements to its plant, but has closed all contracts for the improvements. E. E. Gage, superintendent.

ESSEX JUNCTION.—L. M. Farnham, of Boston, Mass., has, with Mr. Nash, of Burlington, been in consultation with S. A. and C. W. Brownell regarding the development of the water power on the south side of the river for an electrical plant. Plans have been submitted and are under consideration.

VIRGINIA.

STAUNTON.—It is stated that a receiver has been asked for the Augusta Electric Company. The company has failed to pay interest, but claims a contract whereby forfeiture will not lie, and to test this point application has been made for a receiver.

PULASKI.—John F. MacKee, Mayor, writes that bids were received on August 15 for the construction of a building and new machinery for a 150-kw. dynamo. The present plant, 75-kw. dynamo, engine and boiler, will be for sale as soon as new plant is completed.

WINCHESTER.—E. Purcell & Company, of Harrisonburg, are reported to have secured the contract for constructing a dam, power house and raceway along the Shenandoah River, near Millville, for the Winchester & Washington City Electric Railway Company, which is to be used for furnishing power for electricity in Winchester and other towns in this section.

RADFORD.—The Grayson Electrical Corporation, it is stated, will build a power house at Graysontown, eight miles from Radford, to light the towns of Christiansburg, Childress and Riner, furnish power for a contemplated trolley line from Cambria to Christiansburg, besides such factories as may be established along the line. The company has a contract with the town of Christiansburg for the exclusive right to furnish light and power to the town for thirty years. Guy Grayson is president and W. C. Grayson, vice-president.

WASHINGTON.

GRANITE FALLS.—O. Lewis, of Snohomish, is reported to have secured a franchise for an electric light plant.

TACOMA.—The Mountain Home Electric Company has been incorporated with a capital of $30,000 by J. J. Hewitt, of Tacoma, and Seymour H. Bell, of Sumpter, Ore.

BLAINE.—The Blaine General Electric Company, it is reported, has been incorporated with a capital of $50,000 for the purpose of supplying Blaine with light and power. It is to be run by the owners of the Monarch Mill.

PORT TOWNSEND.—A company of local capitalists, who were refused an electric light and gas franchise by the City Council at the last session, are negotiating with the Port Townsend Electric Company for the purchase of its plant and franchise.

PULLMAN.—Improvements are to be made to the city electric light plant. The entire line is to be rebuilt and an electric pumping engine installed for city pumping, and a 75-h.p. motor, direct-connected to a centrifugal pump, 18 additional arc and 50 series incandescent street lamps, 25 to 40 commercial arcs and 1500 commercial incandescent lights are to be installed, and other improvements made. The Washington State College is to be supplied with power. D. F. Staley, Mayor; H. V. Carpenter, Chairman Electric Light Committee.

WISCONSIN.

AUSTIN.—A. S. Campbell is building a power plant near here to supply the city with electricity.

KAUKAUNA.—The Kaukauna Electric Light Company has applied for a lighting franchise in Little Chute, Wis.

BURLINGTON.—At a special election the proposition to vote $12,000 for a municipal electric lighting plant was carried.

JANESVILLE.—The Janesville Electric Company proposes extending its system to Milton and Milton Junction. P. H. Korst is manager.

PRINCETON.—The citizens, it is reported, voted to issue $12,000 bonds to purchase the plant of the Citizens' Electric Light & Power Company.

FLORENCE.—The Pine River Improvement & Power Company is reported incorporated, with a capital of $100,000, by E. W. Hopkins and E. A. Edmunds.

GREENWOOD.—The contract to construct an electric light plant has been awarded to W. D. Lovell, of Minneapolis, Minn., at $14,950. Elias Peterson, City Clerk.

SHAWANO.—The Flattock Water Power Company, of Shawano, has been incorporated, with a capital of $50,000, by H. C. Zachow, Chas. H. Hartley and Frank S. Baker.

FOND DU LAC.—The Independent Light, Heat & Power Company, of Fond du Lac, has been incorporated with capital of $25,000, by Robert Free, G. R. Hoffman and Frank D. Fulton.

PLATTEVILLE.—The Platteville Electric Light & Power Company will this fall add a 50-kw. generator and an 80-h.p. engine, direct connected; beginning early in the year 1906 the company contemplates installing machinery to double the capacity of the plant. J. H. Evans is secretary.

STOUGHTON.—Bids have just been received for electrical apparatus and power equipment, the work to be let as follows: Power house, 150-h.p. water-tube boiler, 150-h.p. steam turbine and generator, 100-kw. generator and 2 exciters, 2 switchboards, arc light transformers, 50 arc lamps, water wheel governor for two 100-h.p. wheels; condenser, feed-water heater and pump, old arc machine and switchboard for sale. John Holton, Chairman of Electric Light Committee.

WYOMING.

LARAMIE.—W. C. Sterne, of Littleton, Colo., secretary of the Arapahoe Electric Company, of Littleton, is reported interested in the construction of an electric light plant at Laramie.

CANADA.

ST. MARYS, ONT.—The citizens are reported to have voted to issue $15,000 bonds for the extension of the electric light plant and water works.

INGERSOLL, ONT.—The Ingersoll Electric Power & Light Company proposes installing new boiler, station equipment, etc. H. Richardson, manager.

BRANTFORD, ONT.—The Brantford Electric & Operating Company, Ltd., proposes installing a 500-h.p. steam plant. Louis W. Pratt, superintendent.

MOOSE JAW, N. W. TER.—Bids will be received by John D. Simpson, secretary-treasurer, for a 200-h.p. boiler, 350-h.p. engine, condenser, feed pump and heater, 225-kw. alternating-current generator, exciter and switchboard.

WESTMOUNT, QUE.—Improvements are to be made here at a cost of $200,000, including the construction of an electric light plant. Ross & Holgate, of Montreal, Que., are the engineers in charge. A. D. Shibley, assistant secretary-treasurer.

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MODERN RAILROAD TERMINAL POWER PLANT.

GENERATING STATION OF THE NEW YORK CENTRAL & HUDSON RIVER RAILROAD AT WEEHAWKEN, N. J.

The New York Central & Hudson River Railroad has recently completed at its Weehawken, N. J., terminal a magnificent power plant, the purpose of which is to generate electricity to light the large car storage and classification yards, depots, shops, elevators, docks, and to furnish power to repair shops, transfer bridges, roundhouse, grain elevators, etc. The plant has a total capacity of 2000 rated boiler horse-power, and embodies in its design the latest practice for power and lighting service. Alternating current is used almost exclusively, 600-volt current being used for power and 2300 volts for lighting, the latter being stepped down to lower voltages where desired, and transformed into direct current in a few instances. The electric lighting system comprises both arc and incandescent lamps, enclosed arcs and 110-volt, 32, 16 and 8-c.p. incandescent lamps being used. A huge export grain elevator lately erected on Pier 7 is equipped throughout for motor drive, the total capacity installed aggregating 3300 horse-power, and in order to to provide a minimum risk from fire and explosion these motors are all of the induction alternating-current type.

FIG. 1.—ENGINE ROOM, TERMINAL POWER PLANT OF THE NEW YORK CENTRAL RAILROAD AT WEEHAWKEN, N. J.

The length of the yard at Weehawken is over a mile and a quarter and power is used at widely scattered points, the depot and roundhouse being at one end of the yard, the marine shops at the other end, and the huge grain elevators in the middle. The point of greatest power consumption being at the elevators, the power plant is located almost exactly at the middle of the yard for economical reasons. It was impossible to locate it close to the elevators because of poor foundation facilities, so the power house was erected in a recess at the foot of the Palisades at a point opposite the elevator on Pier No. 8. This situation is inaccessible for yard track purposes and is of sufficient size to provide for the power house and also for considerable extension. The transmission distance to the elevators from this point is over a thousand

feet, but since 600-volt alternating current is used for distribution this is not prohibitive. The distance to the marine repair shop at the north end of the yard is about half a mile, while the distance to the depot at the south end is over 3500 feet.

The power house is an exceptionally well-designed structure of steel and brick, divided longitudinally into an engine room located on the river side and a boiler room on the west side. There is a 12-ft. high basement under the engine room for steam piping and auxiliary equipment, while under the operating floor of the boiler room there is a 10-ft. high basement for the ash conveyor system. Concrete enters largely into the construction of the building, the wall and engine foundations and the floors being of this material. The entire main roof and the roof of monitors are constructed of 3-in. concrete slabs reinforced with No. 16 galvanized iron wire. The most notable feature of the power house construction is that the floor of the basement is at ground

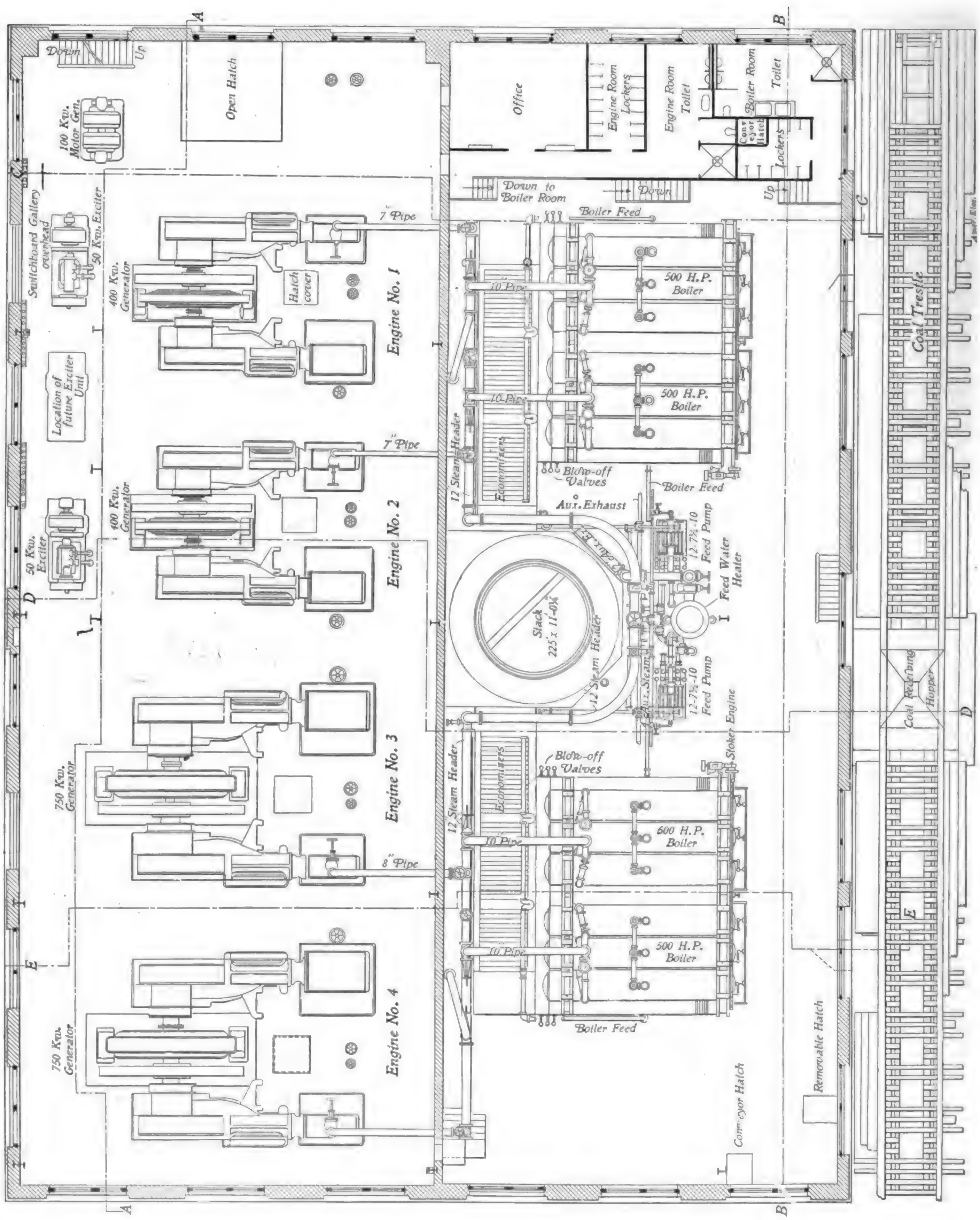


FIG. 2.—PLAN VIEW OF THE ENGINE AND BOILER ROOMS OF THE NEW YORK CENTRAL TERMINAL POWER PLANT AT WEEHAWKEN, N. J.

level. This not only renders the basement light and conveniently accessible, but also permits of its being well ventilated and dry, a point often overlooked in many power plants.

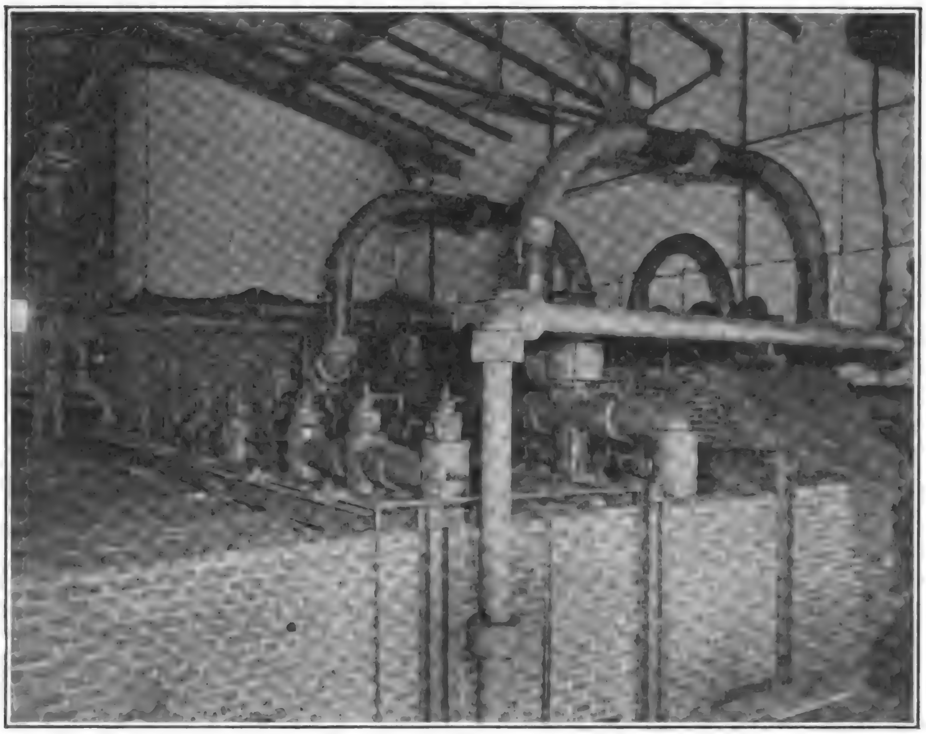


FIG. 3.—STEAM PIPING ABOVE BOILERS.

The boiler equipment consists of four 500-h.p. horizontal water tube boilers set in two batteries of two each, one on either side of the chimney. The boilers were built by the Altman & Taylor Machinery Company, Mansfield, Ohio, and each is equipped with a Foster superheater supplied by the Power Specialty Company, of New York City. The boilers are carried upon wrought-iron supports independent of the brickwork. Other details of the boiler equipment and superheater are given in the following table:

BOILERS.

Nominal Horse Power	500 H. P.
Heating Surface	5,000 sq. ft.
Working Pressure	150 lbs.
Test Pressure after Erection	200 lbs.
No. of Sections	21
No. of Tubes	252
Kind of Tubes	"Knobbled," Hammered Charcoal Iron.
Diameter of Tubes	4 inches
Length of Tubes	18 ft.
No. of Steam Drums	3
Length of Steam Drum	23 ft. 3⅝ ins.
Diameter of Steam Drum	36 ins.
Thickness of Steam Drum Plate	⅜ in.
No. of Mud Drums	1
Diameter of Mud Drum	12 ins.
Length of Mud Drum	12 ft. 6 in.
Thickness of Mud Drum Plate	1¼ ins.
Size of Steam Opening	10 ins.
Number and Diameter of Dry Pipes	3—5 in.
Outside Dimensions of Setting	23 ft. 3 ins. by 15 ft.
Maximum Height of Boiler Above Floor Level	18 ft. 3 ins.
Shipping Weight per Battery	196,000 lbs.

SUPERHEATERS.

Type	Flue Fired
Square Feet of Superheating Surface	1,250 sq. ft.
No. of Tubes	24
Diameter of Tubes	4 inches
Shape of Tubes	⊃
No. of Sections	3
Diameter of Connections to and from Superheater	3—5-in. pipes.

The boilers are equipped with safety high and low-water alarms, which, together with other boiler fittings, are finished in polished brass. The feed and other auxiliary pipe connections are of heavy brass and the blow-off piping is fitted with flange connections. The feature of the boiler and superheater construction is that all joints are made metal to metal, without packing of any kind. The superheaters are located in the setting above the water tubes and form an integral part of each boiler. They are provided with proper connections for by-passing, and are designed to raise the temperature of steam delivered from each boiler at its rated pressure of 150 pounds per square inch to 550° F.

Roney stokers were installed by Westinghouse, Church, Kerr & Co., and each pair of stokers is operated by a Westinghouse special stoker engine. With coal supplied in proper size and with proper firing, the stokers are guaranteed to consume the coal completely and smokelessly. Other information regarding the stoker equipment is contained in the following table:

STOKERS.

Type	Roney Overfeed
Width, Over All	12 ft. 6 ins.
Length, Over All	8 ft. 2 ins.
Grate Area	112 sq. ft.
Weight, Each	21,600 lbs.
Size of Stoker Engine.	4½ in. cylinder diameter, and 4-inch stroke
Horse-power of Stoker Engine, at 80 lbs. steam pressure	5 H.P.
Horse-power Required to Operate Each Stoker,	1 H.P.
Draft Required by Stoker, inches of Water	⅜
Draft Required at 150 per cent. Overload, Inches of Water	½
Rating, Coal per sq. ft. of Grate per Hour	15 lbs.
150 per cent. Overload Rating, Coal per sq. ft. Grate per Hour	22 lbs.

Two fuel economizers, made by the Green Fuel Economizer Company, Matteawan, N. Y., are installed in the smoke flues at the rear of the boilers. Each unit consists of eight vertical cast-iron tubes con-

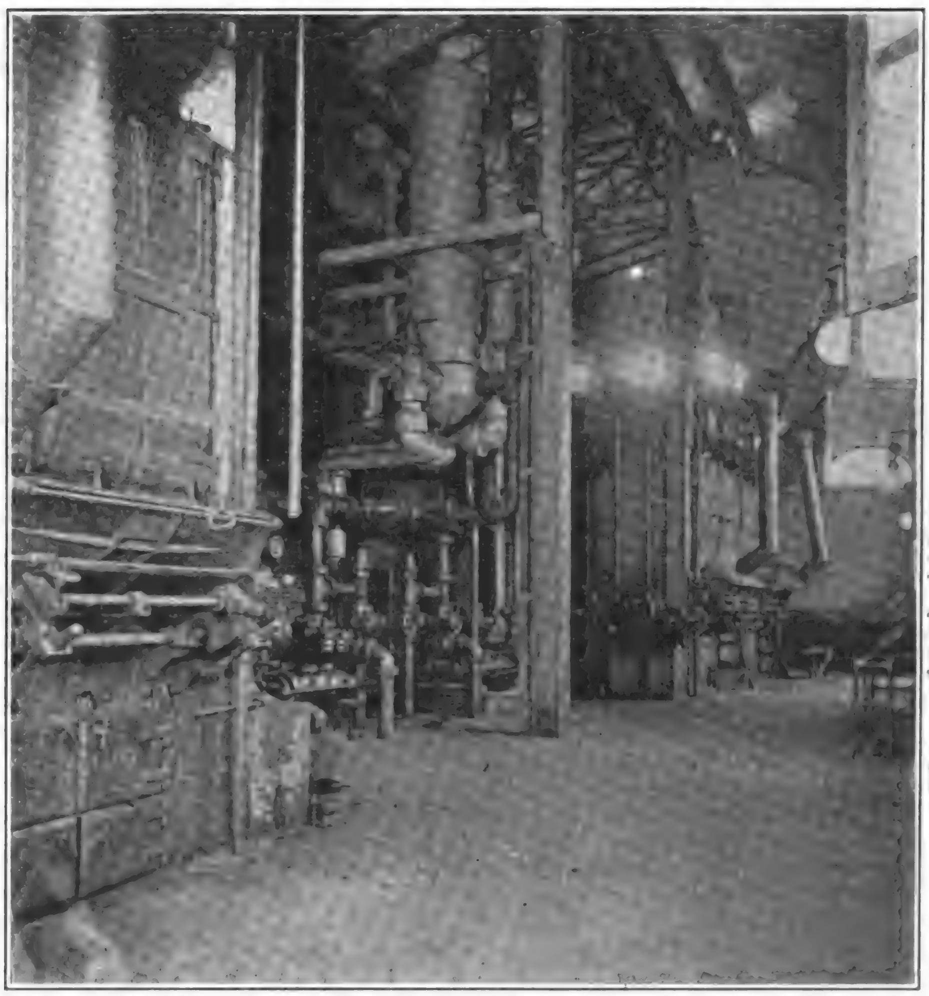


FIG. 4.—BOILER ROOM OF THE NEW YORK CENTRAL TERMINAL POWER STATION.

nected to headers at top and bottom, each row forming a section. The feed-water enters at the cooler end of the flue and leaves at the end nearest the end of the boiler. The usual scraping devices are employed for removing soot from the tubes, and these are driven by three-phase alternating-current induction motors. The principal dimensions of the economizers are tabulated below:

ECONOMIZERS.	
No. of Tubes in Each Section	8
No. of Sections in Each Economizer	44
Length and Diameter of Tubes,	10 ft. by 3⅞ ins. diameter
Total Heating Surface of Each Economizer,	4,576 sq. ft.
Power Required to Operate Scrapers	2 H.P.
Size of Scraper Driving Motors	2 H.P.
Test Pressure for Economizer and Fittings,	350 lbs. Hydrostatic

The stack is of the radial brick type and of ample size to handle normal and 50 per cent. over loads on the present boiler equipment and the two additional boilers for which space is reserved. It is 225 feet high with an internal diameter of 10 feet, but is proportioned for an increase of 50 feet, or 275 feet future height. The base is square, but changes to half-octagonal above the boiler room floor. The round section of the chimney begins just above the economizers. The chimney was built by the Alphons Custodis Chimney Construction Company, New York.

A complete system of conveyors and elevated storage hoppers is provided for handling and storing coal and ashes. A transverse belt conveyor carries the coal from the receiving hopper, and a longitudinal bucket conveyor elevates it to the storage bins above. The system has a capacity for handling 30 tons of coal per hour. A coal trestle is provided at the rear of the building, next the Palisades, by means of which carloads of coal are dumped directly into the receiving hopper and crusher. The pockets for the coal are of steel construction; these are 13½ x 15 feet square at the top, and the chute opening at the bottom is 19 feet above the boiler room floor. The ash pockets are of similar construction, but instead of slanting toward the boilers they slant toward the outside wall so as to deliver ashes into the cars on the trestle outside. The hoppers are carried partly by the side wall and partly by steel columns rising at the boiler fronts and extending to the roof trusses. The total storage capacity is 140 tons of coal, and the ash hoppers are designed to take care of three days' accumulation. The entire system is automatic in its operation.

FIG. 5.—VIEW OF STATION SHOWING CABLE TOWER AND CONDENSER.

Coal is dumped direct from the cars into the receiving hopper, whence it passes into a large coal crusher capable of taking care of 30 tons of coal per hour. From the crusher the coal is delivered into the conveyor system consisting of a belt conveyor running transversely a distance of 18 feet and a bucket conveyor which receives the coal from the belt conveyor and carries it to the storage pockets. The belt conveyor is 18 inches wide and is designed for a belt speed of 400 feet per minute. The main bucket conveyor is of the usual link type. Automatic trips are located over the storage pockets to dump the buckets wherever desired. A reversible variable-speed, three-phase alternating-current motor is used to drive the bucket conveyor, while the belt conveyor and coal crusher are driven through a counter shaft by a variable-speed, three-phase non-reversible, alternating-current motor. The ashes are taken directly from the ash-pits by the main bucket conveyor, an apron being provided to permit of their being scraped into the passing buckets. The entire conveyor equipment, including the crusher, was furnished by the Exeter Machine Works, of Pittston, Pa.

The boiler feed and blow-off piping have been carefully designed, so that troubles from leakage of blow-off valves are provided against, and the possibility of shut down of any boiler, due to lack of feed-water supply, is eliminated by a duplicate system of feed piping. The boiler-feed piping system is carried entirely in the basement below the boiler-room floor. A duplicate source of water supply for the boiler feed pumps is provided at the southwest corner of the boiler room basement, where connections are made with the high and low-pressure water mains of the city of Weehawken, N. J. Duplicate suction connections lead from Worthington water

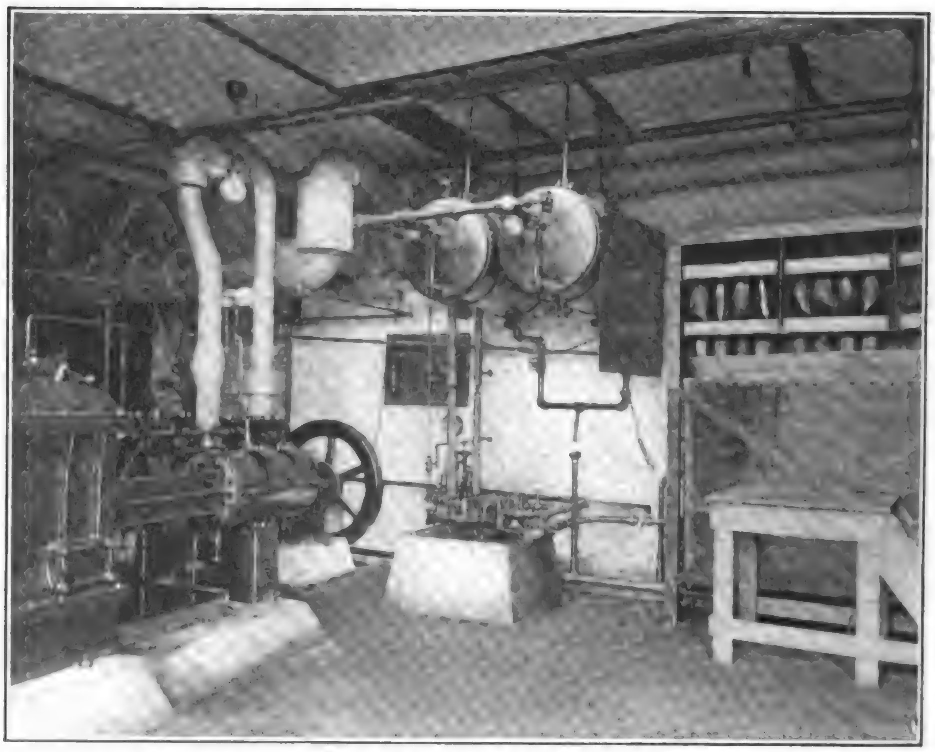
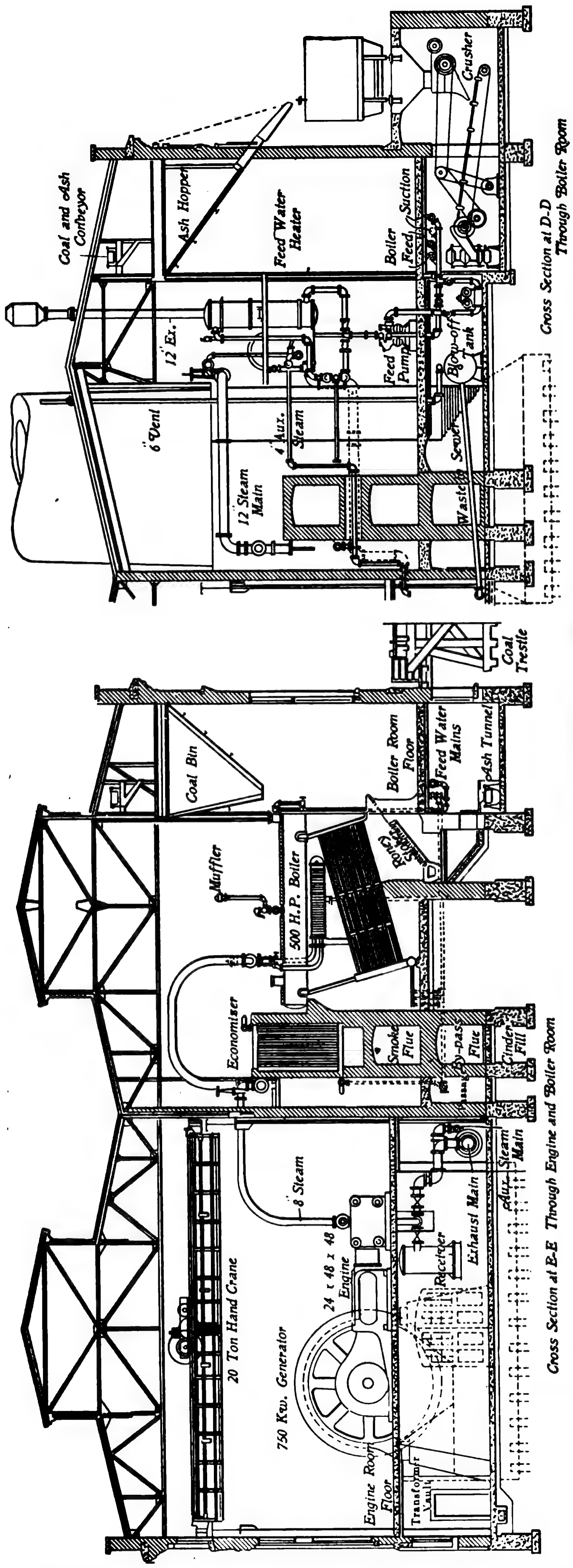


FIG. 6.—CONDENSING AND OIL FILTERING OUTFIT IN BASEMENT.

meters to the feed pumps. These pumps deliver through the feed-water heater to the economizers, thence to duplicate 4-inch feed mains, from which connections are made to the boilers. The feed enters at the base of each of the three steam drums of each boiler.



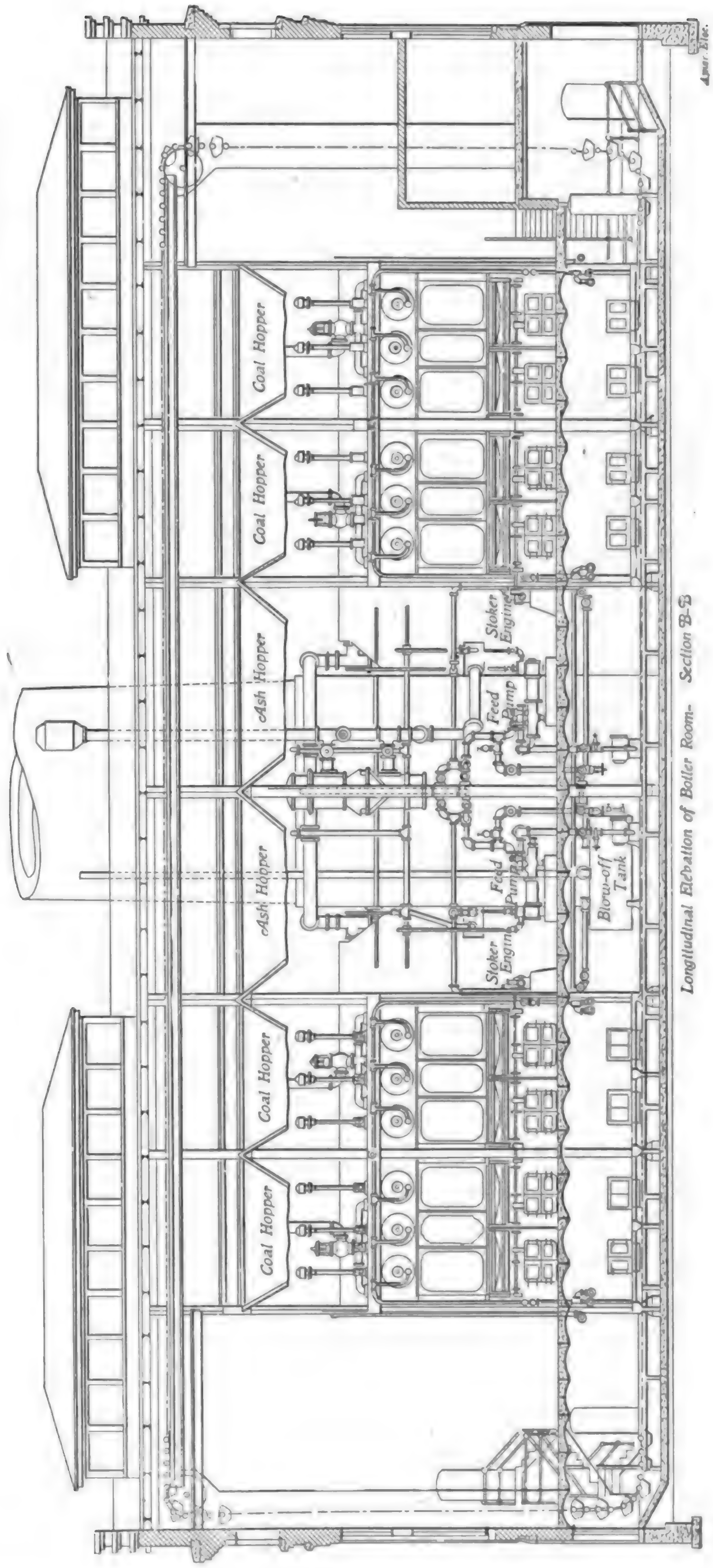


Fig. 7.—Cross-Sectional View of Station and Sectional and Longitudinal Elevation of Boiler Room.

The feed-water connections are very flexibly arranged. Either the feed-water heaters or the economizers may be by-passed, or both may be by-passed at once, so that in this way either one or both of the feed pumps may deliver either cold or hot water to the boilers through either leg of the duplicate system of piping. Galvanized mild steel pipe, tested at 400 pounds hydrostatic pressure for 48 hours, is used throughout the entire feed system, and relief valves are located in the delivery of each pump, so that excessive pressure in the feed system, due to a delivery pipe from the pump being clogged, is prevented.

Two boiler feed pumps are provided, each of which is capable of feeding the entire equipment. The pumps are Worthington outside-packed plunger pressure pumps, with "pot" valves fitted to handle cold water. Each has steam cylinders 12 inches in diameter and water cylinders 7½ inches in diameter, with a common stroke of 10 inches. The capacity of each pump is 22,000 gallons of water per hour delivered against a pressure of 300 pounds at a piston speed of not over 100 feet a minute. The pumps are located on the boiler room floor adjacent to the base of the stack. The feed-water heater is located directly above the feed pumps, upon a special steel platform, as shown in Fig. 7. This heater is a vertical Wainwright enclosed-tube type heater and is capable of raising the temperature of 70,000 pounds of feed water per hour from 40° to 100° F., with 7000 pounds of exhaust steam at atmospheric pressure. The blow-off piping system includes, besides the three blow-off connections from each boiler, a blow-off from each economizer and one from the feed-water heater. These all empty into a special blow-off tank through a 4-inch blow-off main; a 6-inch overflow leads from this tank to the sewer. The blow-off connections from each boiler consist of three 2½-inch asbestos-packed blow-off cocks at the mud drum, these cocks being connected to the blow-off main through a 2½-inch Cadman angle blow-off valve. The blow-off piping is flange-connected and tested under high pressure. Tees and crosses are used in place of elbow fittings wherever possible, blank flanges being applied to the vacant sides, thus permitting ready access for cleaning out pipes. The blow-off tank is located beneath the feed pumps and consists of a horizontal cylindrical tank 4 feet in diameter and 11 feet long. It is designed to withstand a pressure of 200 pounds per square inch and is fitted with two inlets on the top for receiving the blow-off connections from the boilers, and a 6-inch pipe leads from the top of the tank to the roof. This serves as a vapor discharge to atmosphere. A 6-inch overflow also leads from the side of the tank to the sewer.

Figs. 2 and 7 show plan and elevation views of the power house as well as the steam piping system. The main system is laid out with great care to provide for expansion, and lap-welded mild steel pipe is used throughout. The system begins at the 10-in. emergency and hand-stop valves on the connections from the three superheaters of each boiler and lead through easy bends to a 12-in. steam header on the boiler room side of the division wall, from which connections are made to the engines and auxiliary steam pipe system. The steam header is carried on a pipe gallery in the rear of the economizer setting at a height of 19½ feet above the boiler room floor. Where the gallery is interrupted by the base of the stack, the header is carried around in a loop with double-elbow vertical off-set connections at each end. The header is arranged in sections, so as to permit of individual connections between adjacent boilers and engines. There are four sections connected by stop valves, and each of the sections connect with one boiler and one engine. This makes a flexible and convenient arrangement, since the equipment can be cut into four practically separate and individual power plants. The header is fastened rigidly at the middle point of each portion of the gallery and allowed to expand in either direction. Provision is made for expansion at intermediate points of support. Ten-inch stop valves are provided in each boiler connection, one at the boiler outlet and another close to the header. Two valves are provided in each engine connection, one the engine throttle and the other an angle valve just above the header. All connections are made to the header at the top side. The connecting pipes are arranged with long radius bends, the sharpest of these being of 4-foot radius, which lead from each section to the auxiliary steam header in the basement. Drainage is carefully provided for in the entire system, and condensation is minimized by nonconducting coverings on all steam pipes.

An auxiliary steam piping system is provided to supply the pumps, stoker engines, exciter engines and condenser pumps. This auxiliary header extends through the engine room basement at the rear of the large exhaust header. It is made up of two sections of 8-inch pipe, each fed from the main steam header by 4-foot radius bends; both sections are joined together at the middle by a long radius bend of 6-inch pipe to provide for expansion. A 4-inch branch supplies the pumps in the boiler room, and a 6-inch loop extends across the engine room basement to supply the exciter engines and condenser pumps. Auxiliary connections are also provided from this header to the low-pressure cylinders of the large engines. The auxiliary header is divided into two sections by a stop valve so as to eliminate a complete shut down in case of accident.

The main engine equipment consists of two 1200-h.p. and two 650-h.p. compound condensing Corliss engines direct connected to three-phase, alternating-current generators. They are of the heavy-duty cross compound type, with receiver, and the generators are located between the cranks. The engines are of the improved horizontal Corliss design recently brought out by the Westinghouse Machine Company. They operate at a throttle steam pressure of 140 pounds and at an exhaust vacuum of 25 inches. They are designed with particular reference to parallel operation and have similar characteristics of speed regulation. The engine guarantee provides that when the load is suddenly thrown on from no-load to full-load the engine shall not vary in speed sufficiently to permit the generator to run ahead or fall behind a machine running at absolutely constant speed of the same number of revolutions per minute, by more than .15 of one degree. The important dimensions of the engines are presented in the following table:

TABLE I.—ENGINE DIMENSIONS

	1200 H.P.	650 H.P.
Diameter of high-pressure cylinder	24 ins.	20 ins.
Diameter of low-pressure cylinder	48 ins.	40 ins.
Length of stroke	48 ins.	42 ins.
Speed, normal full load	94 rev. per min.	120 rev. per min.
Horse-power, indicated, normal	1,200 h.p.	648 h.p.
Cut off, high-pressure cylinder, normal	26 per cent.	
Cut off, low-pressure cylinder, normal	37 per cent.	
Cut off, high-pressure cylinder, maximum	75 per cent.	
Diameter of crank shaft, center	21 ins.	17 ins.
Diameter of crank shaft, bearings	18 ins.	15 ins.
Diameters of piston rods, each	5 ins	4½ ins.
Face of crosshead gibs	22 ins. long by 11 ins. wide	
Crosshead pins	length 9 ins.; diameter 8 ins.	length, 7¼ ins.; diam., 6¼ ins.
Crank pins	length 9 ins.; diameter 9 ins.	length, 7¼ ins.; diam., 7¼ ins.
Main bearings	length 36 ins.; diameter 18 ins.	length, 30 ins.; diam., 15 ins.
Length of connecting rods, center to center	132 ins.	115½ ins.
Diameter of connecting rods, at center	6 ins.	5 ins.
Diameter of flywheel	216 ins.	180 ins.
Width of face of flywheel	17 ins.	14 ins.
Weight of flywheel	60,000 lbs.	40,000 lbs.
Thickness of piston, H. P. Cylinder	12 ins.	10 ins.
Thickness of piston, L. P. Cylinder	24 ins.	20 ins.
Diameter of main throttle valve	8 ins	7 ins.
Diameter of main exhaust valve	18 ins.	14 ins.
Length of engine, over all	33 ft. 6 ins.	28 ft. 8 ins.
Width of engine, over all	27 ft.	21 ft.
Height of engine, over all	12 ft.	10 ft.
Total weight of engine, complete	280,000 lbs.	195,000 lbs.

The governors are of the safety fly-ball type and control the cut-off in both the high and low-pressure cylinders. The speed control is such that speed variation does not exceed 2 per cent for a 5-pound change in steam pressure above or below normal, and 3 per cent when full rated load is instantly thrown on or off. In addition to the safety feature of the governor, the engines are fitted with Monarch safety stops, which are arranged to automatically cut off the steam supply in case the engine speed increases more than five revolutions above normal. The engines operating the exciters are 90-h.p. vertical cross-compound non-condensing engines of standard Westinghouse design. Each is direct connected to a 50-kw., direct-current generator and operates at the same steam pressure and superheat as the larger engines.

The cylinders of all the engines are designed to permit two reborings, and expansion and contraction are carefully provided for in their construction. Metallic packings are used throughout and each cylinder is covered with magnesia non-conducting covering and lagged with polished sheet-iron lagging with copper corner strips. Snifting valves are provided on each cylinder and connections are also provided at each end for indicators.

The oiling system is quite complete. A complete automatic closed oiling system is provided on each engine, in addition to triple sight-feed lubricators and hand cylinder oil pumps upon each cylinder. Drip pans and return pipes collect and lead the

used oil back through an oil filter and purifier to a 150-gallon return tank, whence it is pumped to an elevated 150-gallon supply tank. A complete piping system leads from this tank to the various sight-feed oil reservoirs and to all other parts of the machinery requiring lubrication.

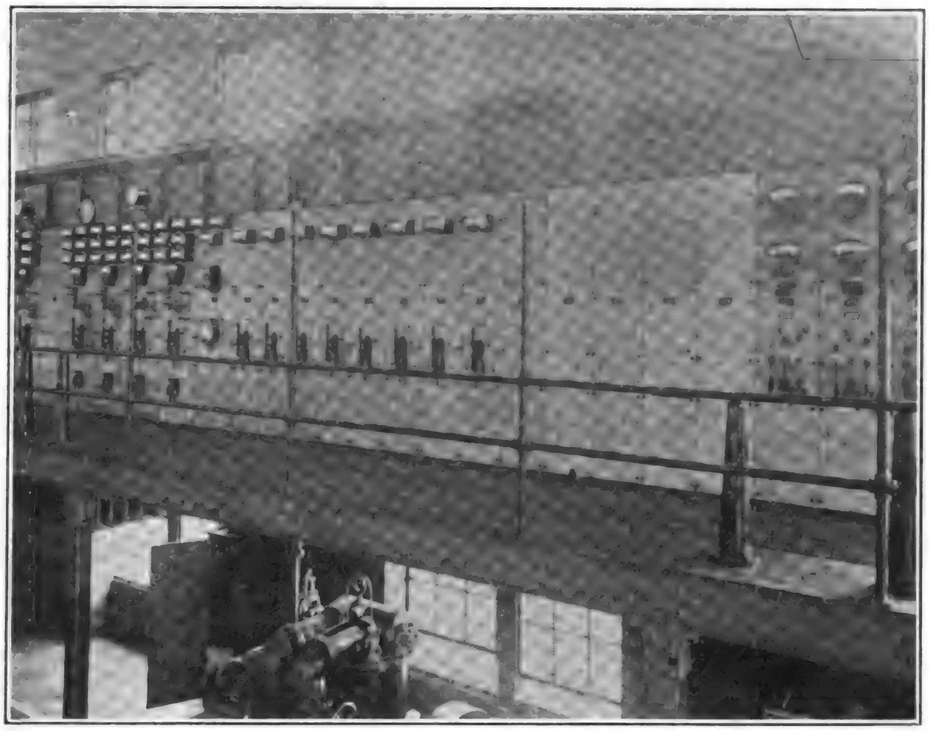


FIG. 8.—PARTIAL VIEW OF SWITCHBOARD.

Two systems of exhaust piping are installed; one taking care of the exciter engines, condenser pumps and boiler-feed pumps, and the other taking care of the exhaust from the main engines. The former delivers to the atmosphere through the feed-water heater, while the latter delivers to the condenser. The main exhaust is made up of two sections, one of 20-inch and the other of 30-inch cast-iron pipe running horizontally through the engine-room basement to the condenser connection outside the southern end of the building. The condenser, which is shown in Fig. 5, is of the barometric central-jet type. It is situated over the hot well and is connected to a 30 x 20 x 20 x 24-inch cross in the exhaust pipe riser, on the top side of which cross is a 24-inch atmospheric relief valve. The condenser has two cast-iron cones, each flanged for a 20-inch exhaust connection, and it also has a 10-inch cold-water injection connection. A dry air connection is provided, and a 10-inch tail pipe extends from the condenser chamber to the hot well. Circulating water is furnished by two steam-driven centrifugal pumps, which take their suction through special strainers and foot valves from an intake well receiving water from the Hudson River. The suction connections are of 12-inch, and the delivery of 10-in. pipe. A dry vacuum pump is provided for removing the accumulated air from beneath the condensing cones. The capacity of the condensing outfit is sufficient to take care of 55,000 pounds of exhaust steam and to maintain the vacuum when the generators are running at their full rated load. The capacity of the circulating pumps is sufficient for condensing all the steam and also provides for heavy overload.

The engine room is provided with a 20-ton single-trolley traveling crane, having a 50-ft. span. This was furnished by the Alfred Box Company, Philadelphia, Pa., and is operated by hand power from a platform suspended from the bridge.

FIG. 9.—MOTOR-GENERATOR AND EXCITER UNITS.

The electric equipment at the power house comprises two 750-kw., 600-volt, three-phase, 25-cycle, alternating-current generators built by the Bullock Electric & Manufacturing Company, two 400-kw., 2300-volt, three-phase, 60-cycle alternators built by the General Electric Company; one 100-kw., 2300-volt, 60-cycle, 600-volt, 25-cycle motor-generator; two 50-kw., 250-volt, direct-current exciter units, one 20-h.p. and one 15-h.p., 220-volt induction motors, one 5-h.p. and four ¼-h.p., direct-current motors. Nineteen 110-volt, alternating current, and eight 220-volt, direct-current arc lamps, together with 185 16-c.p. incandescent lamps are used in lighting the station.

The switchboard is located on a gallery in the southeast corner of the engine room, as shown by Fig. 1. It is of standard General Electric make and is made up of 28 panels. Their order from right to left is as follows: Three exciter panels, five blank panels and eight feeder panels. The first of these feeders is blank, the next feeds Piers 2, 3, 4, ice house and transfer bridges for car floats; the next supplies power to the coaling station and the next furnishes power to the central station auxiliaries. Then follow lighting panels, one feeds the marine repair shop and new ferry house, another serves Piers 2, 3, 4, transfer bridges, old grain elevator, yards and signal tower, another lights the passenger station, engine and gas house, coaling station and milk sheds, while the last serves the power station. A totalizing panel for the 2300-volt current comes next, followed by four panels, two of which are devoted to the motor-generator set and two to the 2300-volt generators. The next panel is vacant and is followed by two 600-volt generator panels and one totalizing panel for the 25-cycle current. The last three panels on the board are feeders supplying the new grain elevator with electricity for light and power.

The circuits supplying light and power to the new grain elevator run across the yard in underground conduit to a manhole in front of Pier 8 and then continue parallel

to the Hudson River to a manhole in front of Pier 7, whence the wires lead to the elevator.

The elevator equipment consists of twenty-three 100-h.p., 550-volt, three-phase, 25-cycle induction motors driving elevator legs; two 75-h.p., seventeen 40-h.p., two 10-h.p. and one 5-h.p. induction motors with their starting compensators, fuse casings, etc. These are with few exceptions of General Electric make. Seventy-eight 32-c.p., three hundred and thirty-five 16-c.p. and ninety-six 8-c.p. incandescent lamps are used for lighting this elevator and two 4000-watt and three 2000-watt electric heaters are also installed.

The other feeders for lighting and power are carried from the switchboard in lead-covered cables of No. 2 B. & S. wire to the top of the cable tower shown in Fig. 5, whence they are distributed on overhead pole lines to the various points of current consumption. The main pole line skirts the foot of the Palisades and branches, carrying sub-feeders cross the yards to the water front wherever necessary.

The motor equipment along the water front and in the yards is as follows: At the transfer bridges for car floats two 10-h.p., 440-volt induction motors are used in operating the aprons; the coaling station is equipped with a 15-h.p. induction motor, and the ice house has one 3-h.p. and one 5-h.p. induction motor for operating an ice crusher, etc. Piers 1 and 2 have each two 5-h.p. induction motors for operating bag and sack conveyors and one 1-h.p. motor. Pier 4 is equipped with one 1-h.p. and four 5-h.p. induction motors; it is lighted by forty-six arc lamps and four incandescent lamps.

Piers 2 and 3 have 336 and 273 incandescent lamps, respectively, with an arc lamp outside each pier. Enclosed arc lamps are used throughout the yards, at the marine repair shop, ferry house, yard master's office, ice house, transfer bridges, marine and locomotive coaling station, ferry bridges, passages, waiting rooms, racks, railroad platforms, immigrant waiting room and express sheds. A small motor-generator is located in the railroad station to furnish 220-volt, direct current for operating fan motors in the restaurant.

The transformer equipment throughout the yard is as follows: At the ferry house Pier 17, one 7½-kw.; marine repair shop, one 15-kw. and three 30-kw.; grain elevator, Pier 8, one 25-kw.; Pier 4, two 15-kw. and three 7½-kw.; shop and signal tower, one 10-kw.; Pier 3, one 30-kw. and three 3-kw.; paint shops, one 5-kw.; ice house, one 5-kw.; Pier 2, one 30-kw. and three 10-kw.; transfer bridge, three 5-kw.; milk platform, one 10-kw.; coaling station, three 5-kw.; engine house, one 5-kw.; sub-station near ferry, one 100-kw.; marine coaling station, one 3-kw. and three others.

We are indebted to Mr. Edwin B. Katte, electrical engineer of the New York Central & Hudson River Railroad, who designed the plant, and to Mr. J. Stehlin, mechanical engineer, for courtesies extended in the preparation of this article.

METALLIC PACKINGS.

BY R. T. STROHM.

Metallic packings for the rods and stems of steam engines, compressors and the like, are intended not only to fulfil all the purposes for which fibrous packings are used, but also to give increased durability. Being made of metal, it is reasonable to suppose that the amount of wear between the packing and the rod will be considerably less than in the case of fibrous packing. This conclusion is borne out in practice, since a rod which is properly packed with a metallic packing will give a much longer service, before repacking, than if it were supplied with the ordinary fibrous kind.

But, further than this, the metallic variety is also intended for situations and conditions under which the ordinary packings

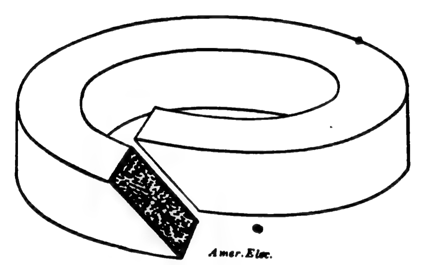


FIG. 1.

would fail entirely, or at best have only a short and unsatisfactory life. Engines using highly superheated steam or even saturated steam of extremely high pressure, present such conditions. The vegetable nature of most of the fibrous packings makes them readily susceptible to the action of steam at high temperatures. It is true that fibrous packings composed largely of asbestos have been put forward for high-pressure work, and have met with success. But there is this point to be remembered: No fibrous packing can preserve its original inherent lubricating qualities for any great length of time when subjected to high pressures and temperatures. And this accounts for the burning out of some fibrous packings. Once the material has lost the greater portion of the lubricant with which it was originally saturated, it will grow dry and hard, and repacking will be necessary to prevent damage to the rod.

With metallic packing there is no need of anxiety on the part of the engineer lest the packing char or burn. Its metallic nature prevents such action. However, it does become necessary to furnish continuous lubrication so that the friction with the rod shall be reduced to a minimum, the wear lessened, and the life of both rod and packing extended. In this case, there is no reliance, for continuous operation, upon the lubricant contained in the packing when first put in place. It is to be understood that the foregoing remarks apply to those forms of packing built up of solid metal rings, and not to the plastic varieties.

In Fig. 1 is shown a form of metallic ring packing, made up in rings of the proper size to fit the rod and stuffing-box. These rings are placed one on top of the other until sufficient to fill the stuffing-box properly, after which the gland is tightened, as in the case of fibrous ring packings.

The material of which the ring is composed is a soft anti-friction metal, which, after being drawn into fibres, is wound into rings of approximately the size and shape required and then saturated with graphite and high-grade mineral oil. The rings are next placed in molds and heavy pressure is put upon them to bring them to the exact size, after which they are covered with a thin coat of rubber. This rubber simply holds the rings in shape while they are being handled, and is quickly worn off on the side next the rod, leaving a bright, soft, oily, metallic surface against the rod. The ring is elastic, and, being of a metallic alloy which melts at more than 500° F., there is no danger of its failing even under extraordinary conditions of pressure and temperature.

There are a number of packings of this nature, differing simply in the form in which they are sold. In one case, the babbitt is fused with graphite so as to form a spongy mass, into which oil is mixed until a plastic substance is formed which may be pressed easily into any stuffing-box. In another, the mixture has a granular appearance, and is put up in long, narrow cotton bags, much resembling sausages. Lengths are cut from these to form rings which are applied in the same way as rope packings. The cotton soon wears away, leaving the composition next the rod.

In Fig. 2 is shown a form of wedge packing. Each of the rings *A*, *B*, *C* and *D* is made in two pieces, molded to the wedge form as shown, with one flat face and one beveled on each. The flat faces of each pair of adjacent rings are placed together, so that when a slight pressure is brought to bear by the gland, the rings slip

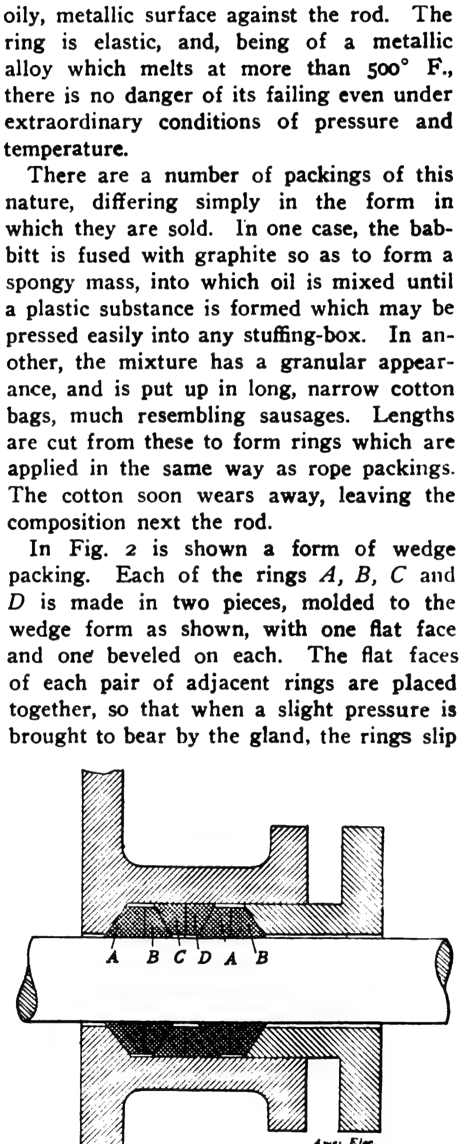


FIG. 2.

along their beveled faces, the rings *A* and *B* being forced against the rod and *C* and *D* against the walls of the stuffing-box. The rings are composed of bearing metal and graphite, and can be made to fit any form of stuffing-box.

A simple form of metallic packing is shown in Fig. 3. It is composed of rings made in halves, which are placed around the rod in such a way as to break joints. The central ring *A* is forced against the rod, and the end rings *B* and *C* against the wall of the box. Thus, the babbitt ring *A* makes the joint. The spaces between and out-

side the rings permit the collection of condensation and lubricants, which are relied upon to keep the packing cool. This is a floating packing, also; that is, it follows the rod when the latter has a slight lateral movement due to imperfect alignment.

The great majority of metallic packings, instead of being either plastic or elastic, are of the solid type, like that illustrated in Fig. 4. This figure shows the packing applied to a rod without making use of the old stuffing-box and gland, which is the manner in which many metallic packings must be applied. The reason is that the construction of the packing is such as to prevent its going into the stuffing-box.

The packing consists of three pairs of

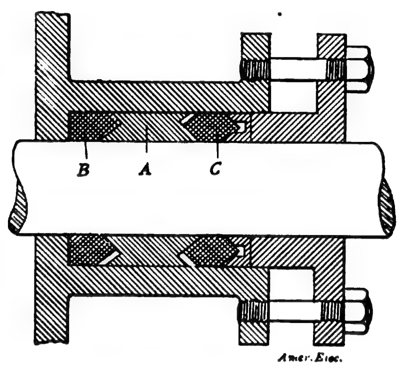


FIG. 3.

rings at *A*, *B* and *C*, each pair contained in grooves in a casing. These grooves are just wide enough to allow the two rings to fit in snugly side by side, and not too tightly to prevent lateral motion. The packing rings thus are floating, that is, moving with the rod, so that if the rod is not centered exactly, or if it is slightly bent, the rings are free to follow it in its lateral movement in the box.

Each ring is composed of three sections, the mode of cutting the ring being clearly shown in Fig. 5. The three segments meet along the faces *A*, *B* and *C*, and, if these lines are prolonged, they will intersect so as to form an equilateral triangle whose center is at the center of the rod. The purpose of this is obvious. Frequently, the

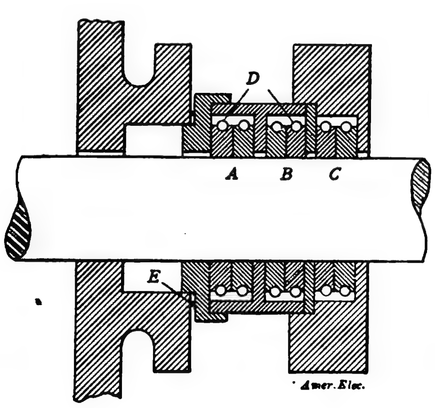


FIG. 4.

rod is not uniform in diameter, or, perhaps, it may be worn slightly oval. If a solid ring were used about the rod, leakage would certainly follow. But, with the three-piece ring, the sections may adjust themselves to the shape of the rod. If the rod diameter increases slightly, the sections are forced apart, sliding upon the flat surfaces *A*, *B* and *C*. This enlarges the triangle formed by these faces, but its center still lies at the rod center.

A spring, *D*, surrounds each ring, lying in

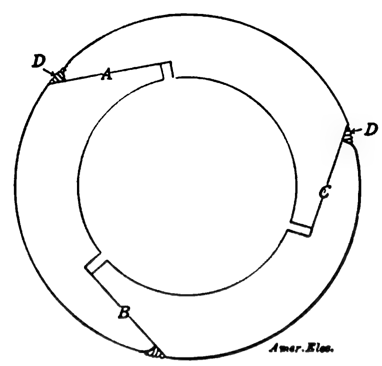


FIG. 5.

a groove cut for it in the back of the ring. It is made of a composition of metals which is unaffected by heat, and it holds the segments of the ring together, close to the rod at all times. The rings themselves are commonly made of soft grey iron, since it meets all ordinary requirements. However, for special conditions, brass and bronze may be used. The casing containing the rings is made of cast-iron, and it is customary to put a lead wire gasket against the flange of the stuffing-box, as at *E*, to prevent leakage past the casing.

The casing containing the packing rings may be made either solid or split in halves. It is evident that if made solid it will be

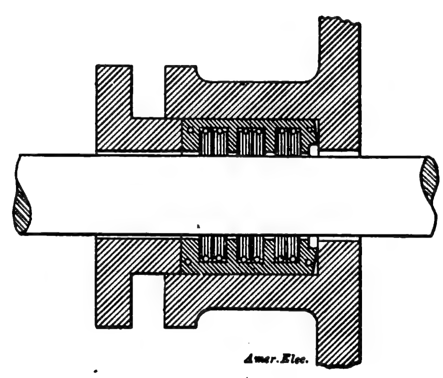


FIG. 6.

necessary to disconnect the piston rod in order to apply the packings. The split case, on the other hand, may be placed on the rod and then bolted together.

A packing of somewhat similar nature is shown in Fig. 6. Here, however, the ordinary stuffing-box is used as a receptacle for the case containing the rings. The rings are laid together in pairs, each pair occupying a separate groove, allowing lateral vibration. Each ring is composed of two pieces, which are dowelled together and surrounded by a spring. In applying the packing, the rings are placed on the rod so as to break joints, the case placed over them and screwed together, and the whole slid along the rod into the stuffing-box. Both the rings and the case are given a coating of cylinder oil while they are being put together, and a lead joint is made between the bottom of the case and the bottom of the stuffing-box.

The packing illustrated in Fig. 7 differs in some of its details from the two just described, although its general arrangement is much the same since it has six rings, in three pairs, placed in casing compartments. The casing, however, is not a single piece, but is made up of several separate parts. The packing rings, also, are different. In each pair there is a broad ring and a narrow ring. The broad ring, shown at *A*, is of three segments, held together by the usual outside spring. But one segment carries the dowel pin *B*, which fits into the opening between two of the segments of the adjacent narrow ring, *C*. This provision assures the placing of the rings of each pair in such relative positions that the points where the segments of one ring meet shall

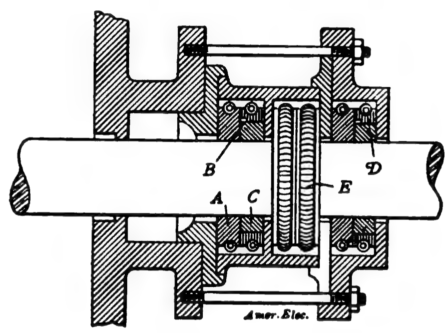


FIG. 7.

come midway between the points on the adjacent ring. The narrow ring *C*, while composed of three parts, is surrounded by an outer or cap ring *D*, which is grooved to contain the spring, *E*. It will be observed that when the packing is applied outside the box, it extends for a considerable distance along the rod. If there is very little clearance between the crosshead boss and the gland, it may be impracticable to use metallic packing of this kind.

Some novel features enter into the construction of the packing shown in Fig. 8. The usual three-part casing is used, containing three pairs of packing rings, which are free to move sidewise in their several

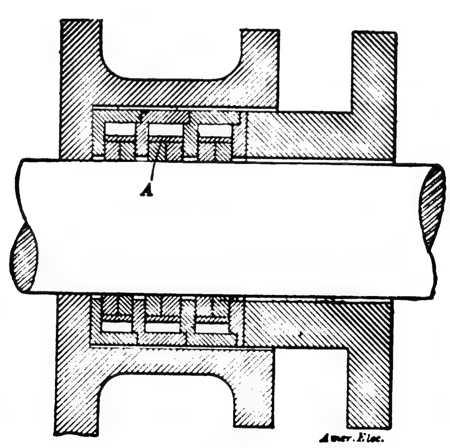


FIG. 8.

compartments. Each one of the rings is divided into three pieces, which do not meet one another when placed around the rod, but are held together by a split ring, *A*, against which press flat springs. This is perhaps more clearly shown in Fig. 9, which represents a section at right angles to the

axis of the rod. In this figure, the three parts of the ring are shown at *A, B* and *C,* surrounded by the split ring, *D.* Between this ring and the solid outer casing, *E,* a number of flat springs, *F,* are placed. The pressure of these springs forces the ring segments tightly against the rod, while the ring, *D,* prevents displacement of the

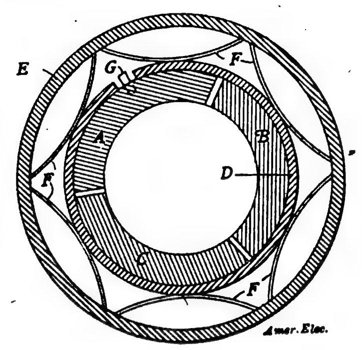


FIG. 9.

pieces. The pin, *G,* which is placed in one of the sections, and extends into the opening between the ends of the split ring, *D,* prevents the rings from turning on the rod, and thus assures the fact that the ring joints of adjacent rings shall always be staggered, thereby avoiding leakage.

Fig. 10 shows a longitudinal section of a packing which presents a number of interesting features. At the bottom of the stuffing-box is a flanged ring, *A,* which serves to hold one end of the helical spring, *B* central in the box, thus preventing its touching the rod and scoring it. This spring presses against the follower plate *C* and thus holds the packing in position. The outer face of the ring plate *C* is beveled and fits snugly against the babbitt packing ring *D.* The latter in turn bears against a smaller babbitt ring *E,* which is beveled at the same angle as *D* along the outer face. Both of the rings *D* and *E* are enclosed by the casing *F.* It is evident that the pressure of the spring *B* is transmitted to the follower *C* and thence to the packing rings, which, because of the wedging effect

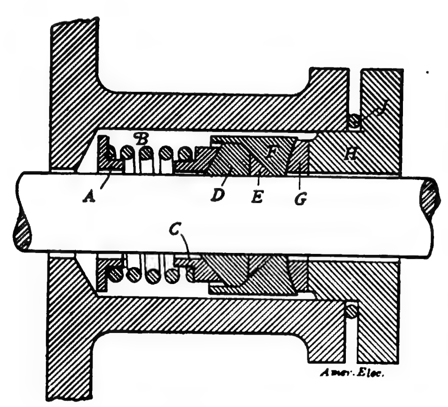


FIG 10.

of the casing *F,* are forced tightly against the rod, sliding inward upon both *C* and *F.* The rings *D* and *E* are split, but their joints are staggered to prevent leakage, a lug on *E* being supplied so as to insure the correct relative positions of these rings. The straight projection or lip at the inner end of the casing *F* is to enclose the ring *D* and receive the follower *C.* The outer end of the casing is given a concave face, which fits upon the convex surface of the ring *G.* The curved surface along which *F* and *G* meet is spherical, and the joint is, therefore, a ball joint, which permits the rod to move somewhat in any direction, laterally, without causing leakage. The joint between the ring *G* and the gland *H* is a ground

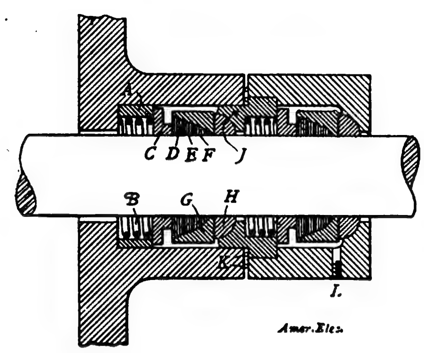


FIG. 11.

joint, to preclude escape of steam. Thus all chance of leakage along the rod is cut off. Between the gland and the flange of the stuffing-box a joint is made with a soft copper wire *J,* thus effectually preventing escape of steam at this point. This packing is not designed differently for each separate case, but is capable of being applied to any engine without necessitating any change in the stuffing-box. This is a point considerably in its favor.

A packing which has great flexibility is shown in Fig. 11. The flat ring *A* is placed at the bottom of the stuffing-box, and inside it the coiled spring *B.* Upon the spring is set the collar or flanged follower *C,* its flange bearing against the soft metal packing rings *D, E, F,* enclosed in the cup *G.* Then a ball ring *H,* whose cross-section is a quadrant, is located with its flat face against the outer end of the cup, and the ball seat, with its concave face, is laid up against the ball ring. This ball seat *J* holds a second spring, which is followed by another series of rings in the same order as previously described. Thus, there are prac-

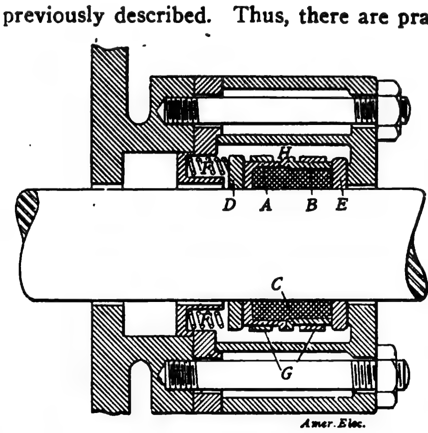


FIG. 12.

tically two sets of packing, one in the stuffing-box and one in the casing outside it.

As in the previous type, the pressure of the spring is just sufficient to hold the parts in place against the friction. The setting of the packing rings against the rod is done by the steam pressure, so that the friction is not the same at all points of the stroke, but varies nearly with the change of pressure in the cylinder. The taper on the inside of the cup *G* serves to force the rings against the rod, when they are acted upon by the steam pressure. The ball joint permits vibration without leakage. A copper or lead wire joint is made at *K* to prevent escape of steam. At *L* is a small hole tapped for the attachment of a drip pipe, by which all moisture of condensation which works out along the rod may be removed. The same hole may also be used for injecting oil into the casing to lubricate the packing. Oiling in this manner gives a bath of lubricant contained in the casing, through which the rod must move. This avoids the unsatisfactory method of lubrication often adopted—dropping oil on the rod just outside the stuffing-box and trusting that it will work its way inward to the packing.

The babbitt rings *D, E, F,* which come in contact with the rod, are cut in halves, with perhaps a sixteenth of an inch between their ends. When the rings have conformed to the shape of the rod, the ends of the rings will soon meet, which prevents their being jammed further into the cup, thereby prolonging their life, without spoiling the tightness of the joint.

Another packing applied in an external casing is lilustrated in Fig. 12. The packing rings *A* and *B,* lined with babbitt *C,* are held between the two collars *D* and *E.* The faces of these collars are at right an-

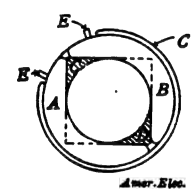


FIG. 13.

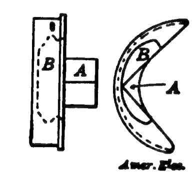


FIG. 14.

gles to the rod axis, and hence the packing rings are free to slide from side to side. The springs *F, F,* serve to hold the rings in place when there is no steam pressure upon them. With steam pressure in the chamber *H,* the rings are held tightly against the rod.

Each packing ring is in two parts, making four segments in all, which are interlocked when in place. Fig. 13 shows a transverse section along the plane in which the two rings meet. *A* and *B* are the two parts of one ring and *C* and *D* the babbitt projections from the other ring. The two parts *A* and *B* are held together by a band spring, *C,* which in Fig. 12 is denoted by *G.* The pins *E, E,* prevent the shifting of the steel spring around on the ring.

In Fig. 14 is shown a single segment, from which its form and construction is apparent. The lug *A* is merely an extension of the babbitt lining *B* of the ring. The distance this lug projects is just equal to the width of a ring. The projection has two flat surfaces, meeting at right angles, and one curved surface whose curvature is that of the rod. When the segments are put together this lug fits beneath the two ends of the adjacent ring, as shown at *C,* Fig. 13.

These are by no means all of the types of metallic packings. There are many more. However, the various kinds illustrated will

serve to indicate the ends toward which designers have worked to produce a good metallic packing. First, tightness of joint, whether under steam pressure or under a vacuum; second, a minimum of friction and wear; third, simplicity and freedom from continual care and adjustment; fourth, applicability to various conditions without change in the design or construction of the engine; fifth, low first cost and reduced cost of maintenance. The packing which combines the greatest number of these desirable features is, doubtless, the one which will be in greatest demand.

FIRE PROTECTION IN TELEPHONE EXCHANGES.

BY H. S. KNOWLTON.

The importance of preventing fire losses is recognized today in practically every branch of modern industry, but it would be difficult to point to any application of electricity on a large scale where continuous service is of greater consequence than in the telephone exchange. Valuable as is the central station in urban and suburban life, and indispensable as is the street railway to both city and rural communities, the telephone is beyond question the greatest time-saving device of modern times, and therefore the one thing above others which the business world is least able to spare, even for a single hour.

At first blush, the telephone exchange of today might seem to be subject to but a slight fire hazard. There is no generation of power on an enormous scale; the building is frequently heated by either a hot-air furnace of usual design or by a low-pressure steam boiler; the central office equipment presents no high-voltage problems in itself, and the wire plant is reasonably well protected from foreign currents by the lightning arresters and heat coils installed on the main distributing frame or in cable boxes outside the office. A careful examination of many exchanges, however, will show even today practices which deserve criticism, despite the lessons of the great conflagrations of 1904 in the United States and Canada. A great deal has been written about fire risks during the past year, and much has been done to reduce hazards in electrical work no less than in other spheres of activity; but as long as the maximum of precaution is not observed, so long is the subject of vital importance.

The fire risk in the modern telephone exchange depends upon the external hazard, the internal conditions and the precautionary measures adopted. It is often difficult to so locate the building that it will be free from dangerous exposure to adjacent or adjoining structures. If a ramshackle barn, shed, shop or tenement occupies abutting property, it is at times possible to purchase such realty at a fair price and entirely renovate it or else sell the site again for fire-proof buildings only. When this cannot well be done, recourse should be had to seamless fire shutters of wood covered with tinned iron and having locked joints, at all exposed windows. In case such windows cannot be equipped with shutters—and often for aesthetic reasons this is the case—these windows should be glazed with wired glass set in metal-covered frame and sashes. On front windows, as in executive offices, etc., the risk is seldom as great as on the sides and rear, so that in cases where clear glass is used the metallic frames and sashes should be supplemented by tightly-fitting asbestos roller curtains. In all cases it should be possible to close shutters from outside as well as from within.

Empty boxes and packing material should not be allowed to accumulate on the roof, and rubbish of any kind has no business in the yard unless it is stored in covered waste cans of metal construction. In the telephone business there is a constant tendency for rubbish to accumulate on account of the thousands of individual pieces of equipment used in central office work. These all come from the factories carefully packed, and the disposal of the packing cases and boxes is a matter of more than passing importance. Ashes have no rightful place in wooden barrels, and in the matter of these general hazards, the problem does not differ widely from that met in factory and power plant work. Incidentally, it is worth while to provide every telephone office surrounded by a yard with a coil of hose and movable hand reel capable of covering the premises, locating faucets on each side of the building about two feet from the ground. On the roof a hose and water supply is also extremely useful in case sparks and burning brands are blown upon it from external fires. The point of greatest danger from external hazards is usually in the operating room behind the switchboard. Windows are generally cut in the wall here in order to provide ample light for inspection and repair work in connection with the complex cable and cord circuits, relays, lamp and jack banks, etc., which make up the operating features of a multiple board. Wired glass and metal sashes can almost always be used in such windows with perfect satisfaction.

Into modern exchanges 500-volt central station power circuits are frequently carried to supply motor-generators for storage-battery charging or elevator service. The usual precautions recommended by the National Board of Fire Underwriters are imperative in such cases, particular care being taken to prevent contact of the circuits with wood or metal work, pipes and other circuits. Gasoline engines are also widely employed in telephone exchanges for driving generators for battery charging work. The use and storage of gasoline is a matter of dangerous risk on telephone property for the reason that the gasoline vapor collects in low places where it is liable to explode when mixed with a certain percentage of air—about one volume of gasoline vapor to ten volumes of air—but if the apparatus is properly installed and maintained danger may be entirely avoided. An automatic valve which will cut off the supply of gas in case the engine stops should be fitted to every gas engine used in a telephone office, and the exhaust piping of either a gas or gasoline engine should be carried up to the roof with the greatest possible directness. It is bad practice to discharge such pipes into chimneys, the better plan being to either run them upward to the roof through special fire-brick flues in the walls or else to extend them outside the building proper. Separating thimbles should always be provided where such piping passes through woodwork. The storage of gasoline should be effected in a tank located well away from the building out-of-doors, say 30 or 40 feet from the walls. Fire protection engineers are unanimous in the opinion that gasoline should never be stored indoors in any quantity. When it is necessary to keep a gallon or two inside temporarily it should be held in a strong can with a self-closing cover, preferably painted with red stripes to call attention to its dangerous characteristics.

In this connection the use of soldering iron heaters operated by either gas or electricity deserves mention. The important point is to provide both irons and heaters with a non-combustible support. It is not uncommon to see heaters in operation on wooden shelves, so hot that the hand can scarcely bear continuous touch, and in other cases gasoline torches are set on operating-room floors in the most promiscuous fashion. Swinging gas fixtures and the careless use of flexible lamp cord around wood and metal work are responsible for fires in many cases. Paper should never be wrapped around incandescent lamp bulbs, particularly in the vicinity of switchboards. Wire guards ought to be used on all portable lamps, and half shades of metal in cases where screening is necessary. Insulated keyless sockets are also preferable. Gasoline torches and electric heaters ought never to be left burning or connected to the supply circuit during the lunch hour, as the deserted condition of work rooms at such time of day offers especially favorable chances for the spread of incipient fires.

In a properly designed and operated telephone exchange there should be slight occasion for the use of matches. An alternative means of lighting the building is always important in case the regular service fails. Many offices are equipped with gas jets for emergency use, while others rely on candle lanterns. The careless use of matches is one of the most common facts of life, and in the telephone exchange precisely the same caution needs observance as makes for safety elsewhere. This means the storage of all matches in metal boxes with self-closing covers, instead of placing bunches on wooden shelves, on stray brackets, etc. Incidentally, the careless use of tobacco in work rooms, store rooms and closets deserves severe condemnation, and the employment of sawdust spittoons and combustible waste baskets has no place in the telephone office.

A liberal supply of fire extinguishers, fire pails, sand buckets with scoops, dogskin gloves, asbestos or woolen blankets and waterproof covers should form a part of every exchange's equipment. The use of water about the switchboard is poor policy, and here compressed carbonic acid gas extinguishers are specially advantageous. Dry powder extinguishers or bellows filled with

such powder are often desirable, and for general use in hallways, closets and offices this type finds much favor. Sand buckets may be proportioned through the plant as follows: One bucket in the terminal room or at the main distributing frame, and in the operating room one near the head of the board and one for each five sections. Corrosive solution ought never to be used about switchboards and desks, distributing frames, etc., except in extremes to put out the fire when all other means are unavailable. Asbestos blankets are preferably about 36 inches square, and good practice provides one for at least every ten sections of the switchboard. They are particularly useful in putting out fires caused by high-tension crosses. Waterproof covers for switchboards and machinery are desirable in the event of the operating or the power room being flooded by the fire department. To avoid damage by water, switchboard cables should be run at least four inches above the floor, and whenever such cables pass through the floor the opening should be lined with a galvanized iron guard, preferably projecting above the opening high enough to prevent water from flowing through. It is also important to provide such openings with closely fitting covers so that drafts of air cannot circulate between floors.

The proper maintenance of fire-protection apparatus is a matter of the utmost importance. Good practice now provides that water pails be refilled at least once a week, that weekly inspections by a responsible employee be made of the entire equipment, and that extinguishers be discharged and refilled certainly every twelve months. Valves and hose should be tested at least once a week, and fireproof shutters and doors ought also to be tried with equal frequency to make sure that they are in good condition. Thermostat alarms in out-of-the-way corners of the plant are desirable, and between the cord shelf and the multiple jacks on the switchboard asbestos fireproof barriers can be installed with profit. The nearest fire engine house should be equipped with a direct telephone line from the exchange.

The safety of the operating force is of paramount importance, and ample facilities in the way of fire-escapes should be installed. On account of the strict discipline necessary to insure good service, telephone operators as a class are usually cool-headed and can be managed in times of emergency with more than ordinary confidence. Nevertheless, fire drills are worth instituting in offices where the operating room is above the second story, and there is good reason to provide at least two separated exits from such rooms to the street. Fire protection in telephone exchanges is a matter of many small details, but it is not a question of large expense, and there is no excuse whatever for the continued existence of extra hazards in such installations.

Old Engine—An engine, one hundred years old, has been displaced by a steam turbine at Greencroft Mill, Hyde, England. The crank shaft of the engine made 30 r.p.m.; that of the turbine makes 10,500 r.p.m.

ELECTRICITY IN SOUTH AFRICAN MINES.

BY GEORGE E. WALSH.

The use of electric mine pumping apparatus in the South African mines has developed rapidly in the past year, and ever since the close of the Boer war activity in working the old and new mines has progressed steadily. Electricity is gradually displacing steam and compressed air in South African mines for operating hoists, drills, stamps and general mine haulage, but in none of these departments is the change quite so noteworthy as in the pumping line. Attention has been called recently to the durability of the motors used in the Knight's Deep mine prior to the war for pumping purposes, which after being abandoned for over two years in the flooded mine were taken up and put into successful operation again. This incident is of value as indicating the kind of work demanded in many mines of pumping machinery. Unless the pump motors are water-proof and reliable in damp places they cannot prove of great utility. Compressed air displaced steam to a large extent in the chief African mines because of this very quality.

Electric mine pumping is accepted on the Rand as the most serviceable and satisfactory of any system yet tried. Nearly 3,000,000 gallons of water have to be pumped out of the Knight's Deep mine every twenty-four hours, which requires some 12,000 horse-power. At the Robertson shaft three electrically-driven pumps have been in operation for some time, delivering some 400,000 gallons of water a day against a head of 1,250 feet.

At the De Beers consolidated mines at Kimberley, electrical pumps have recently been put in operation. Two of them are of the centrifugal high-pressure type, coupled directly to polyphase motors, each capable of raising 1,000 gallons of water per minute to a total height of 320 feet. The pumps are operated by motors developing 150 horse-power at 730 revolutions per minute. A smaller pump is operated by a 75-h.p. motor, and the water is raised 160 feet at the rate of 1,000 gallons per minute. The pumps are connected with the motors by flexible couplings. The overload capacity of the motors is 100 per cent, and the efficiency of the pumps is 75 per cent at full pressure. The motors are of the enclosed type and practically waterproof and damp-proof. They are so arranged that they can be operated with the least possible fear of damage or injury from weather or careless handling. The pumping can go on night and day when the rest of the power of the mine is shut down. As the air is renewed very slowly in such deep mines the rise in temperature of the motors caused by continuous use is important. In the Kimberley mines the full rise in temperature averages only 18 degrees Centigrade after the motors and pumps have been in operation at full load for many hours.

The experience of mining engineers with electricity in African mines has been so satisfactory that there is little likelihood of further extension of steam or compressed air for operating the pumps there. In nearly all gold and tin mines the amount of water present is so great that the workmen are hampered by it, in nearly all cases the rocks which carry the metals being also "water bearing." On the other hand the immense amount of water needed for the machines used to separate the gold or tin and the dross and gangue makes the presence of a fair amount of water important. The right quantity of water may thus prove of distinct value to miners and engineers have the problem of providing pumps of the right sort to solve before anything else.

The gold mines of South Africa are very deep in many instances, and the amount of water required to be pumped out is enormous and the distance very great. In both the tin and gold mines, the lodes are nearly always at an angle with the horizontal, and the inclination is rather deep. Sometimes the angle leads to such depths that it is impossible to pump the water up to the surface with any degree of success. Several of the shafts have been sunk to 2,000 and even 3,000 feet, and the cost of driving the water up against such a head has been deemed almost too expensive to try. Nevertheless, the presence of gold in paying quantities at these lower depths has stimulated mining engineers to greater effort. Pumping units have been tried on the Rand which force the water up against a head of 2,000 feet and more.

In these experiments electricity has been found the most efficient for a number of reasons. The loss which occurs in steam pipes in deep mines practically excludes steam-operated pumps from use at any depth greater than 1,000 feet. In tests made with steam pipes in mines it was found that steam under a pressure of 45 pounds per square inch through a pipe one inch thick and 7½ inches in diameter lost through condensation 0.183 pound per square foot of surface when the engine was standing, and 0.274 pound when the engine was working. This was equivalent to the loss of 500 pounds of water per hour when the engine was idle and 750 pounds when in operation, in the cases under test.

Further tests made with steam pipes a trifle under 2,000 feet in length, showed a loss of 0.113 and 0.265 pound of water per square feet of surface per hour with the pipes covered. Uncovered pipes showed a loss equivalent to almost one pound of water per superficial foot of pipe exposed. Accepting these tests as representing a fair average of loss, it was assumed by the engineers at the Knight's Deep mine that about 230 pounds of coal per hour would be consumed to make up for the loss of power through condensation in a pipe 2,000 feet long.

On the other hand, the loss of electric power through long circuits underground is almost a negligible quantity. In the German mines of the Harpener Bergbau large electric units have been used which show low cost of operation in deep pits. The depth of one of the shafts where an electric hoist and electric pumps are used is 1,968 feet. The power house is equipped with

a 600-h.p. horizontal compound steam engine direct-connected to three-phase generators delivering current at 2,400 volts with a frequency of 25 cycles per second. This current is used for operating mine hoists and pumps. The latter are far under ground, and the total distance over which the current is transmitted to operate them is 2,460 feet. Double-acting pumps are installed at the bottom of the shaft, and they raise 176 cubic feet of water per minute a distance of 1,476 feet. The motors which operate these pumps run at 65 r.p.m. and operate directly from the 2,400-volt power circuit. The saving obtained from these electric motor-driven pumps is so great that the profits of mining at depths below 1,000 feet have been increased surprisingly.

The added advantages of lighting the shafts and tunnels electrically and of protection from fires and explosions have also tended to increase the preference for electricity in gold mines. In coal mines the danger of fire when the air is full of fine dust and gases has led to the installation of electric units located above ground or with every possible protection when placed in the mines. In most of these cases the frame of the motor and the cases in which the fuses are enclosed are ground securely and the fuses themselves are placed in gas-tight boxes. The slip rings of hoisting motors are also encased in tight boxes. Where the sufficient precaution is taken to prevent the different parts from causing fires or explosions in shafts where the air is liable to carry large quantities of inflammable gases and coal dust, all danger is practically eliminated.

At a recent meeting of the Mining Institute of England, the question of electricity in coal mines was discussed, and as a matter of safety it was decided that pressures of 3,000 volts or more should not be used at all, and the consensus of opinion was that pressures as high as 650 volts should not be used outside the main intake airways or chambers directly supplied from them. Cables carrying high pressures in the mines should be enclosed in armor or iron pipes, and all metal conduits should be connected to earth.

The three-phase system has found more advocates in the mines than the direct current owing to the absence of commutators and the general simplicity of the three-phase machinery. Nearly every kind of mining machinery has been adapted for driving by three-phase motors.

SHOP SYSTEM FOR ELECTRICAL CONTRACTORS.

BY LOUIS J. AUERBACHER.

The shop and accounting system of any electrical contracting business very naturally varies according to the amount of business done, so that it is out of the question to give a system which is applicable to all cases. That described herewith is suitable for a concern doing a general contracting and jobbing business and employing from 15 men upwards. The system is simple and accurate, and the forms used are the result of a gradual development. They are designed to avoid the cumbersome detail common in many record forms, and have been evolved with the life of a number of concerns who make a daily use of them.

WIRE, CONDUIT & CO.
ELECTRICAL CONTRACTORS
[illegible]

Job C № 1350

New York, Sept 11 1905

Charge to John Jones

For work at 1450 - 6th Ave.

Order received by B.B

Order acknowledged 9/12 — Work commenced Sept 12 — Foreman Smith

Contract account X — Work completed ____

Contract new 725.00 — Charged ____

L. & M. or R. ____ — Bill ____ — C/f sent customer ____

Description of work

FORM A (*White*).

Actual size, 9 inches wide by 8 inches high.

The orders, or contracts, received are divided into two classes; those in which a contract for a stated price has been made, and those classed as time and material jobs.

As an example, a contract for wiring a house at a price of $1,000 is received. The original order or contract, properly signed, is filed in a special file, which should be kept in a safe. The order is entered, in duplicate, on a blank, Form A. One copy is given to the foreman and the other is kept in the book. The orders are consecutively numbered, and the contract is then known as job No. C1. The price is not put on the copy given to the foreman, as it is not considered good policy to have the prices of contracts generally known, except to the firm.

The foreman is expected to learn the exact nature of the work, either from verbal description or specification. He then makes

WIRE, CONDUIT & CO.

Supply Department. *Charge to Job No.* ____

New York, 19

Deliver to Name ____

Address ____

Wanted ____

____ *Foreman.* ____ *Gen'l Sup't*

FORM B (*Straw*).

Actual size, 6 inches wide by 8 inches high.

WIRE, CONDUIT & CO.,
1000 Ohm Street,
New York City.

RECEIVING BLANK.

Received from Wire, Conduit & Co., for use on Job No. ____ the following materials:

Received in good order by ____

FORM C (*White*).

Actual size, 6 inches wide by 8 inches high.

a list of the material needed to start the job. This may be done from an analysis of the estimate, or, better still, by an inspection of the building in which the work is to be performed. The foreman then fills out a "material slip" so that the stock clerk can get the materials promptly to the job.

WIRE, CONDUIT & CO.
ELECTRICAL CONTRACTORS
1000 Ohm Street

Job R №. 7994

NEW YORK, Sept. 11 1905

Gentlemen—Please furnish the material and perform the labor for the following work to be done at 670 West 10th St
and charge same to the account of Wm Bradley
Terms ______ ~~Contract~~ New

Description of work *Order received by* ______

Repair broken circuit wire

FORM D (*White*).
Actual size, 7 inches wide by 11 inches high.

Such a slip is shown in Form B. The stock clerk should be prohibited from filling any orders unless the job number is on the requisition as well as the signature of the foreman or other authorized person.

These slips, after being filled, should be carefully filed, so that all slips for one job are together. A good way of doing this is to fasten them into a blank book by pasting the slips on pages corresponding in numbers to the job numbers. In case there are a number of slips for one number, these may be pasted over one another by gumming the edges.

The getting of the proper material promptly on the job is one of the important duties of the stock clerk. He should promptly notify the foreman of any unlooked-for delay, so that workmen are not kept waiting for the necessary material. The cost of errand boys and proper wagon service should not be stinted, as delays in receiving materials promptly cause a considerable leak in the profits. The stock clerk should insist upon getting a proper receipt from the foreman or wireman on the job, for materials delivered. (See Form C.)

Foremen and wiremen should be instructed to measure for special fittings as soon as practicable, so that the material may be on hand when needed. This refers especially to panels, trims, switch plates and all fittings not regularly carried in stock.

Should any extra orders be obtained in a contract job, the order for same should be entered on a separate blank. If the extra is obtained at a stated price, blank Form A is used.

Many extra orders are usually received verbally; they should be acknowledged at once, stating prices and the work to be performed. This will make the settling of the account a simple matter, as any misunderstanding can be adjusted before the work is under way.

For all orders received on which no price has been set the accompanying blanks will be found suitable. In Form D a different letter is used before the number, to distinguish these orders from the stated price jobs. These orders are made in duplicate, a carbon copy remaining in the book. When receiving such an order the customer should be told the price per hour for labor, and, if

A

Anderson B, C 121 L & M 646-732-926
Adams T. B. C 162 L & M 930-1106-1109

FORM G (*Straw*).
Actual size, 5 inches wide by 3 inches high.

practicable, the prices per unit for material. If the order was given verbally, the customer should be asked to sign an order similar to Form E.

The wireman should fill out the reverse side of the slip (see D1), and when finished with the work have it signed by the customer or his representative. This is a check for both the contractor and his customer, and prevents disputes when the bill is received. Time and material jobs, unless properly handled, often lead to disputes. To avoid these, the customer should be advised as to the progress of the work and the approximate cost of the same. If any difficulties arise which will increase the price, he should be informed. The contractor should insist upon the customer or

MATERIAL USED

LABOR ACCOUNT

NAME	SUN.	MON.	TUES	WED.	THUR	FRI.	SAT.	TOTAL	RATE			

Work satisfactory, time and material approved

New York, ______ *190* ______

FORM D1 (*White*).
Actual size, 7 inches wide by 11 inches high.

New York, 190

WIRE, CONDUIT & CO.
ELECTRICAL CONTRACTORS
1000 Ohm Street

Gentlemen: Please furnish the material and perform the labor for the work described below, at

Terms:

Labor to be charged at the rate of $ per day for journeyman and $ per day for helper.

And charge the same to the account of

Signature,

Description of work:

Customers will please note that the time of workman is charged for from the time he leaves the shop until he returns, and a reasonable addition for foreman's time for supervision. Minimum charge one hour, and double time for overtime after hours, Sundays or holidays.)

FORM E (*White*).
Actual size, 7 inches wide by 10 inches high.

his representative checking the wiremen's time, daily. Unless the customer is thus kept advised, much trouble may arise when the bill is presented, and customers are often lost, through no fault whatever on the part of the contractor.

latter is taken from the time sheets. (See Form H for cost sheet.) The cost book will enable the head of the establishment to see the financial condition of every job, which is of great advantage, especially to check the progress of the contract. If the book.) When an order slip is turned in as completed the stock clerk should be notified so that he can promptly arrange to get back the unused material, ladders, scaffolds, etc. Unless this is carefully done much material will be lost, as wiremen are

WIRE, CONDUIT & CO.

Supply Department. *Credit to Job No.*________

New York, *19*

Credit to________

*Address*________

*Send*________

*Goods Can Be Found in, Location:*________

________*Foreman.* ________*Gen'l Sup't.*

FORM F (*Pink*).
Actual size, 6 inches wide by 8 inches high.

COST BLANK.

Name________ No.________

Date Started________ Date Finished________

Contract Price________ Cost________

Details:-

	Mdse.	Labor.

FORM H (*White*).
Actual size, 8 inches wide by 12 inches high.

When surplus material is returned from a job a proper return slip is filled out. (See Form F.) This slip should be of a different color than the stock requisition slips, to prevent errors in entering.

All orders, either contract (C) or labor and material (L and M) are indexed, to prevent the omissions of any slips when entering the charge. The bill clerk or bookkeeper should check them off as billed, or start a tracer for any missing orders before billing. (See Form G for index system.) When making out bills the slip numbers should be placed on them. This makes it easy to look up slips should there be any disputes.

In keeping the cost of a job a loose leaf book is best. The page should be numbered to correspond to the job number. The customer's name as well as details of the job should be on this sheet. In an iron pipe job the number of outlets, switches, receptacles and panels should be given. These details should be copied from the specifications by the clerk who keeps the stock book and serve as a check on the material. If the original contract called for 24 switches and the sheet shows that 28 went out, a reason should be given for sending out the four extra switches. The form also serves to keep cost records per outlet, etc., etc.

The cost books should have the material entered up daily and the labor weekly; the cost is running unreasonably high, a conference should be had with the foreman in order to ascertain the reasons and apply the proper remedies.

The stock room should have a complete line of standard material, especially little fittings which are often required in a rush. Much money is also saved by buying goods in so-called standard packages. Where goods are ordered from supply houses or manufacturers a regular order blank should be used, and this should be the only means of obtaining goods. To be valid the orders should be signed by one or two authorized persons. The job number should be on the order as well as the other information. (See Form I for order bank.)

Where materials are ordered to be shipped direct, the foreman or wireman on the job should fill out a slip (Form J) when he receives such material. This enables the stock clerk to check the bill for material as to quantity and quality.

All supplies received should be entered in a receiving book so that the bills can be checked. (See Form K for receiving

SEND INVOICE BY MAIL ON WHICH NUMBER OF ORDER MUST BE STATED

NOT RESPONSIBLE FOR GOODS DELIVERED WITHOUT PRINTED ORDER

Nº 2099 *New York,*________*19*__

*M*________

*Ship to*________

CHARGE TO ACCOUNT OF **WIRE, CONDUIT & CO.**

Per________

FORM I (*White*).
Actual size, 6 inches wide by 6 inches high.

usually very lax in bringing back unused material to the shop. A system for keeping track of ladders and special tools supplied to wiremen is necessary. A number of hooks are mounted on a board, and these are numbered to correspond to numbers on ladders and tools. When a ladder is sent out a tag is filled out containing the job number, name of workman in charge and date. This is placed on the hook corre-

sponding to the ladder number, and is left there until the ladder is returned or shifted to another job. A similar system can be applied to pipe cutting and other special tools.

Keeping employees' time records and checking the same is naturally one of the vital parts of any shop system. The names and addresses of all employees, together with their rating, such as apprentices, helpers and journeymen, should be noted in a book for that purpose. If the employee is discharged or laid off, a note should be made, together with the reason. If he is found to be proficient in a certain line, that fact should also be recorded. Men are often laid off during slack times, and should the firm require a good man on iron pipe work, a search of the records will enable a postal to be sent to a number of the right kind of men.

A daily record of the disposition of the men should be kept so that the time sheets can be checked, and the numbers of the jobs they are on should be credited to them. If new L and M job slips are issued and assigned to a man, they should be charged to him.

Time sheets should show the employee's name, classification, rate of wages and daily record, and also expenses. (See Form L for time sheet.) An employee should fill out his own time sheet and have the foreman check same. It should then be checked by the general superintendent or some one else in authority, who would use the daily time book for that purpose. The time sheets should be figured and entered in the time book by the bookkeeper. The time charged against the various jobs should then be entered on the cost sheets. All time charged on L and M order tickets should be compared with those tickets, as a check. This will show if it corresponds to the signed acknowledgment of the customer. (See Form D1.)

The cost sheet of a finished job should be compared with the original analysis of the estimate. This will enable the estimating clerk to check up his work, and if a discrepancy occurs, say in labor, it should be brought to the attention of the proper party and an investigation made as to whether the job was poorly handled or the estimate was wrong. The cost sheet will serve as a check both ways.

If a contractor makes his own special fittings and fixtures, and does his own machine and carpenter work, a shop order system is necessary. All material or work ordered from the shop should be ordered on a special blank. (See Form M.)

WIRE, CONDUIT & CO.,
1000 Ohm Street,
New York City.

New York, ____________

RECEIVED on account Job No. ________ for contract of ____________

from ____________ the following material.

Signed ____________

FORM J (*White*).

Actual size, 6 inches wide by 8 inches high.

Our Order No.	Received from	Located	By what Route	Charges	Received by	Quantity	Description of Merchandise	Charge to	Bill Checked	Remarks.

FORM K (*White*).

Actual size, 18 inches wide by 12 inches high.

TIME SHEET

Week Ending Sept 25 1905 **Name of Workman** Burns

Name of Customer and Job No.	Thursday	Friday	Saturday	Sunday	Monday	Tuesday	Wednesday	Total	Rate	EXPENSES—ITEMIZED
C 1350	8	8	4							Alcohol 15¢
R 4780					8	8				
R 5051							8	44	4.00	

O. K. S. S **Foreman.** **Approved** L. B **General Superintendent.**

FORM L (*White*).

Actual size, 11 inches wide by 8½ inches high.

These blanks should be in duplicate and consecutively numbered.

On the reverse side (Form M1) the foreman notes the time, the materials used, and the cost. This will enable a proper record to be kept in the cost book, and also serve for fixing the price to the customer. Where a large number of L and M sheets are made out, it is well to keep a record of them on a separate sheet. (See Form O.) When the bill is sent out the amount is filled in on the sheet by the bill clerk, which shows that the final entry has been made.

A good card index system for following up contract work is essential. Cards printed as per Form P are used. Space is provided for noting whether the service application to the local illuminating company has been made, if the application for inspection to the local inspection bureaus has been made, and also when the certificates were sent to the electric light company, and when returned. On the reverse side is entered the job number of all slips on the job, also the amount of same, and this is totaled when the job is finished. These cards are kept in three drawers of a card file and shifted as the job progresses. One drawer is labeled "Jobs Started," another "Jobs Completed," and the third, "Bills Sent and Paid." These cards also serve as reference for the head of the establishment, and for the collection department.

The departments of a contracting busi-

ness are divided into the executive, accounting, operating and sales. The executive department naturally directs the heads

WIRE, CONDUIT & CO.,
1000 Ohm Street,
New York City.

FACTORY ORDER.

Foreman of Shop:-

Perform the following work on account of Job. No.______

and when finished deliver to______

FORM M (*Pearl*).
Actual size, 6 inches wide by 6 inches high.

of other departments, and by consulting the office records can keep fully posted on all details of the business. The accounting department has charge of all accounts and the

Job No.	NAME	ADDRESS	CREDIT TO	DESCRIPTION OF WORK	PRICE	Workman	Start	Completed	Billed Amount

FORM O (*White*).
Actual size, 16 inches wide by 20 inches high.

cost book. The head of the operating department is the superintendent. He should pass on all estimates and approve all the layouts of different jobs. He is responsible for the profitable and workmanlike results expected, and in large concerns has estimate clerks and draughtsmen to assist him. The foremen report to him, and he should be able to design any special fitting or device found necessary.

Foremen are assigned to districts and should visit all jobs at least once a day, for in no other way can discipline and a fair day's work be obtained from the working force. The foreman should see that proper tools, ladders and material are on the job, and should instruct the workmen how to run their circuits as well as locate outlets, switches, bells, etc., etc. He should order any special panels or other devices in time, so as not to delay the work. If violations are filed oftener than reasonable, he should be discharged for carelessness.

The stock clerk has charge of the stock and the shipping of materials to the jobs. In this department none other than an active, energetic and accurate man should be tolerated, as a careless stock clerk may cost the concern hundreds of dollars. To get the right material to the job quickly, and to order the special devices necessary, requires good judgment and experience. A big leak is possible in this department, and the stock clerk's records should be checked carefully.

The following time and material were used on the enclosed order.

______ Foreman of Shop.

Total Cost______$

FORM MI (*Pearl*).
Actual size, 6 inches wide by 6 inches high.

The stock clerk should be held accountable for all material and tools, and an inventory should be taken at least twice a year. He should keep two files for the material slips; one for those filled and another for those unfilled. He should advise the foreman if he anticipates any undue delays in receiving material ordered, so that the foreman can govern himself accordingly. If the stock clerk finds that he cannot entirely fill an order for material, he should make out a due ticket similar to Form B, except that it should be of a different color and read on top "Due Ticket." The foreman can then see at a glance how many due slips there are and get after the stock clerk.

The sales department should have as many solicitors as are found profitable. In many cases the foremen are used as salesmen, and if they have the time it is a good plan. Workmen on the job, especially in private houses, make the best salesmen for extras, and if properly instructed will bring in considerable business. One salesman should look up the real estate transfers and removals. He should call on parties who have purchased houses and solicit business. If that branch of the work is sufficient to keep a man busy, another should solicit business among architects, builders and decorators. A proper card "follow up" system, of which there are many on the market, should be used.

All requests for estimates should be turned over to the salesman who usually calls on that customer, if it be an old account; if not, the salesmen should be consulted to see if they know the party or any one having influence in that direction.

At certain times in the year removals are frequent and placards in the windows of stores announce the intended removal to other quarters. A call on such parties frequently results in orders.

The system described can be broadened or cut down to meet requirements. The owner may be his own superintendent and foreman, as well as do his own estimating and draughting. The bookkeeper can do all the bookkeeping and collecting, etc., etc.

A system of this kind will be found very valuable and is inexpensive. It must be kept up to be of value, as partial records of costs and other details are worse than none. Oftentimes in an endeavor to improve matters, too theoretical a view is taken leading to the employment of elaborate and complicated forms. Records should be as few and simple as possible. A good system

C NO. 1350 Sept 11-05
CHARGE TO John Jones
FOR WORK AT 1450-6 th Ave
SALESMAN B.B SERVICE APP Sept 14 05
DEPT. UNDER

APP		CERT		APP		CERT	
W	F	W	F	W	F	W	F

PRICE	COST	BILLED	PAID	ALLOWANCE
725 00	575 00	940 00	935 00	5 00

STARTED	COMPLETED	DATE BILLED	DATE PAID
9/12	9/30	10/1	10/3

WORKMAN	MATERIAL	DATE	O. K.

R SLIP NOS.
4780
4950
5051

ELECTRIC LIGHT CO
Sent D 10/1 U 10/1 Ret. D 10/2 U 10/2

FORM P (*Light Blue*).
Actual size, 6 inches wide by 4 inches high.

is additionally valuable, as it does not make a "one-man business" out of a concern. A new man, by consulting the records, should be able to grasp his duties, as well as the swing of the business, at once.

AN INTERESTING GAS ENGINE PLANT.

BY K. S. HOWARD.

Although small gas engines have attained wide usefulness in isolated plant service during the past few years, the range of adaptability which such installations at times illustrate is worth emphasizing again. In certain establishments economy of space is of such far-reaching importance that no boiler plant can be built on the premises, and in all commercial installations it is desirable that the cost of power be reduced as much as possible without hampering the service.

A case in point is the plant of "Green, the Druggist," in Worcester, Mass. The use of electricity in drug stores has increased greatly of late, and the possibilities of the incandescent lamp in the way of effective illumination for advertising and display purposes can no longer be ignored by progressive houses. The advent of the electric sign and the small motor has introduced new methods into many branches of retail business. Most city drug stores are hard pressed for space, and the compactness and cleanliness of electrical equipment long since demonstrated the superiority of electric power in situations where the direct use of gas, kerosene oil or acetylene would be unfavorable to the production of the best quality of work.

The Green plant is located in the basement of the store of that name at Main and Pleasant Streets, Worcester. The corner occupied by the establishment is one of the busiest in the city, and at this point rents are close to the maximum. A large number of 16-c.p. incandescent lamps are used in the store proper, around the soda fountain and counters, in ceiling clusters and in the windows, while outside the building illuminated signs equipped with 4-c.p. lamps are in nightly service. Several large fans and enclosed arc lamps are also in use, and in the basement is a 3-h.p. motor which drives an ice crusher and an ice cream freezer by belting and a short line shaft. These machines are used for the soda fountain supply. Current for lighting and small power work is drawn from the plant by several adjoining merchants.

The plant has been in service some 3½ years and is said to have paid for itself in two years. From the æsthetic standpoint, the equipment offers small attractions because of its exceedingly cramped location, which is so unfavorable as to preclude anything satisfactory in the way of a photograph. Squeezed into little more than a basement closet 21 ft. long, 9 ft. wide and 7 ft. high, and surrounded by packing cases and the miscellaneous débris which only drug and grocery stores seem to accumulate below stairs, it looks as though operating efficiency might be out of the question, at first sight. The aspect of things changes, however, as one examines the equipment and notes the character of the service given.

Gas is supplied from the mains of the Worcester Gas Light Company to the plant through a 60-light meter located under the sidewalk, beneath Pleasant Street. From the meter the gas is led to the engine, which is a two-cylinder Nash machine of 30 horsepower, working on the usual four-stroke cycle, and governed by the hit-and-miss explosion method. The engine is of the vertical type, weighs 26.6 pounds per horsepower, or 8000 pounds total, and occupies a floor space of 72 x 74 inches, with bed plate. It has two 72-in. fly-wheels, makes 275 r.p.m., and drives by belt from a 36 x 16-in. pulley a 17.5-kw., 4-pole General Electric dynamo, over-compounded from 110 to 115 volts, speed 1175 r.p.m., direct current. The full capacity of the engine is 300 16-c.p. lamps, and its cylinders are cooled by city water. A two-panel slate switchboard is placed between the engine and its generator and against one of the walls a 15-point end cell switch for use with the storage battery.

The storage battery is located in a basement room and passageway adjoining the engine room and it consists of 72 of the Electric Storage Battery Company's E-11 cells, in E-11 glass jars, capable of discharging at the rate of 25 amperes on the 8-hour basis, or 100 amperes on the 1-hour rate. These cells are arranged in single rows and in three tiers along the walls of the room and the sides of a narrow passageway through which persons frequently walk, and the jars are protected by doors in front of the wooden skeleton frame which supports them. The cell connections are of the single strap lead type, bolted, and the jars are insulated from the frame in glass trays filled with sand, which is an effective, if unusual method of preventing leaks of current. Ventilation is provided for by grated openings in the sidewalk above. One of the switchboard panels is given up to the battery; it contains a central zero Weston 100-ammeter, an underload circuit-breaker and rheostat for equalizing the charging on both sides of the battery, pressure wire connections being made on the adjoining panel to enable each half of the battery to be plugged into the voltmeter. The battery is charged in two sections, which are placed in parallel by switches on the board. The other panel contains various feeder switches, a voltmeter and an ammeter, field rheostat and a double-throw, double-pole switch for throwing the plant upon the mains of the Worcester Electric Light Company in time of emergency.

The engine and dynamo are usually operated from 2 p. m. to 1 a. m., the battery carrying the load at other hours. The battery is charged from 2 to 5 p. m.; it then is used to help out the engine and generator in the evening peak load, which lasts until 11 p. m., and another hour of charging follows from midnight until 1 a. m. The schedule for cutting in lights is: Two inside arcs, 4 p. m.; fountain lights, 5 p. m.; clusters of incandescents and two outside arcs, 6 p. m.; windows and signs, 7 p. m. Lights are cut out as follows: Clusters and electric sign, 11 p. m.; fountain, midnight; all other lights, 1 a. m., except 6 lights in the store, 1 in the cellar, 1 in the cellar stairway and 1 on the second floor, which burn all night.

Very little attention is required by the equipment beyond reasonably frequent inspection to see if everything is working properly. It is estimated that the cost of power per kilowatt-hour at the switchboard is about 3 cents. That the equipment has stood the regular service of over three years to the satisfaction of its owners is a point of interest concerning its economy and reliability, housed as it is in anything but attractive quarters. The wisdom of the emergency connection with the local central station's circuits is beyond question, although little resort to such current is reported. The plant was installed by Plummer, Ham & Richardson, of Worcester, and on the score of compactness and low power cost it is of considerable interest. Figures of first cost are not at hand, but a reasonable estimate is 4 cents per kw-hour to cover fixed charges and operating expenses, based upon gas at $1 per thousand cubic feet. The sale of current to adjoining premises is also a help in the net cost of operation.

Abstracts from Foreign Contemporaries

Arc Lamp Carbon Ends.—L. Bernard describes in a recent issue of the *Elektrotechnische Zeitschrift* an economical method of using up arc lamp carbon ends. This consists in cementing several ends together so as to form a single carbon. The cementing operation is performed by cutting the ends of the pieces so as to make them fit together and then covering the ends with a paste made of water glass and powdered carbon. The pieces are finally pressed lightly together. Made-up carbons of this kind were found satisfactory in every way. They could be used on either alternating or direct-current circuits and burned just as well as new carbons, even at the joints. The resistance of the made-up carbons is slightly higher than the others, while as regards mechanical strength the made-up carbons when subjected to uniform stress, were found more liable to break between joints than at them.

Electrically-Driven Fire Engines.—It is announced in the *Zeitschrift für Elektrotechnik* that two fire engines and a car for carrying accessory appliances, all electrically-driven, have recently been put into service by the Vienna fire brigade. The accumulators, which, is is said, are sufficient to propel the car for some 28 miles at a speed of 12½ miles per hour, are placed in a compartment in front of the driver's seat over the front wheels. India rubber

tires, 125 mm. (49 in.) thick, are fitted to the wheels, which are 850 mm. (2 ft. 9½ in.) in diameter. Each of the front wheels is provided with a 35-h.p. Lohner-Porsche hub motor. The controller provides for the following speeds: 5.6, 6.8, 12.5, 17.4 and 22.4 miles per hour.

Direct-Current Power Transmission at 57000 Volts.—The *Bulletin de l'Institut Electrotechnique Montefiore* contains the following details of a remarkable high-tension direct-current transmission scheme at present under construction. The transmission is between Montiers, in Savoy, and the town of Lyons, and is over a distance of 110 miles—the greatest yet undertaken in Europe. The power to be transmitted is 6500 horse-power, and it is to be generated at 57,000 volts. This will be obtained by connecting four groups of generators in series, each group being directly driven through a flexible coupling by a turbine of 1570 horse-power. Four generators, giving 3560 volts each, form a group. The receiving station at Lyons will contain six groups of motors coupled to railway generators. Each group will consist of two motors, each taking 73 amperes at 3840 volts. In this installation the earth is employed to limit the static voltage of the line, but it does not actually form one of the conductors, except in case of accidental damage, in which case it acts as a reserve line. In this way the cost of the line is practically the same as when the earth is used as the return, while certain useful advantages are obtained. Thus the stray currents are, normally, entirely suppressed, and, in case of breakdown, are reduced by half, while another important advantage is the fact that the earth is always available as a reserve line in case one of the conductors fails. It is expected that this installation will be at work in less than a year.

The Thury Automatic Regulator.—Some interesting particulars regarding the Thury automatic regulator are given in the London *Electrician.*. This device may be arranged to regulate all kinds of quantities, such as speed, pressure, current, etc., but is primarily intended to keep the voltage of electric generators constant by regulating the field resistance. In order to combine rapidity and reliability of action with sensitiveness, the field rheostat is not actuated directly by the fluctuations in voltage; but is operated by a small electric power motor of about 1/20 horse-power, the regulating mechanism being merely brought into play or stopped by the fluctuations of voltage. Fig. 1 is a diagrammatic sketch of the voltage regulator for alternating-current systems, being practically identical with that used in direct-current installations. H is a toothed wheel keyed to the shaft, *L*, which carries the switch arm of the rheostat. *D* is a casting which is rocked to and fro about the shaft, *L*, by the motor referred to. The pawls, *I* and *I'*, are attached to *D* in the manner shown, but are held off the toothed wheel by the spring-actuated levers, *K* and *K'*. Each of these two levers carries a projection at its upper end; the projection on *K* passes normally above the blade, *C*, while that on *K'* rocks to and fro underneath this blade. Consequently, when the blade, *C*, is lowered or raised, it will strike against *K'* or *K*, respectively, thus permitting pawls, *I'* or *I*, to drop into the teeth of the wheel, *H*. The latter is now rotated in the one or the other direction—thus cutting in or cutting out field resistance—until the blade, *C*, regains its horizontal position, when it no longer strikes against *K* or *K'*. Pawls, *I* and *I'*, are then drawn by spring-action out of con-

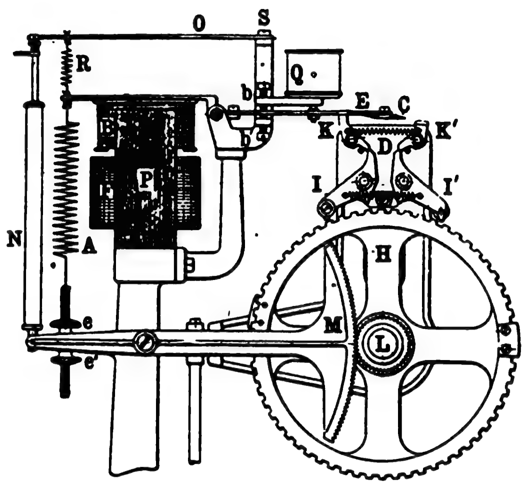


FIG. 1.—THURY AUTOMATIC REGULATOR.

tact with the teeth of the wheel, *H*. Referring to Fig. 1, the electromagnetic mechanism for controlling the position of the blade, *C*, is as follows: *P* is one of the limbs of the laminations which constitute part of the magnetic circut through which a flux is maintained by the coil, *F*. A very light coil, *B*, connected across the bus-bars whose voltage is to be controlled, is free to move up or down above *F*, the movement being limited by adjustable stops, *b* and *b'*. When the voltage of the supply is normal, the current through *B* is such that the lever, *E*, carrying the blade, *C*, is in a horizontal position and nothing happens. But when the supply voltage is higher or lower than the normal, then a correspondingly larger or smaller current flows through the shunt coil, *B*, which rises or falls in consequence and causes the blade, *C*, to move into the way of the oscillating levers, *K* and *K'*, thus actuating the rheostat as previously explained. The coil, *B*, moves against the tension and compression of the two springs, *A* and *R*, the latter being, in its turn, attached to the free end of a flat spring, *O*, fixed at *S*. The free end of *O* is also in connection, through the intervention of a dash pot, *N*, with the pivoted lever, *M*, which takes up a position in accordance with the position of the switch arm by means of the gearing shown. This arrangement, as may be easily understood by reference to Fig. 1, tends to steady the movement of coil, *B*, and to bring it back speedily to its horizontal position after having been deflected. In order to prevent vibrations of the blade, *C*, in regulators for alternating current or where the regulation is required to be unusually sensitive, a dash-pot, *Q*, is also provided. Standard regulators are dimensioned in such a manner that the toothed wheel, *H*, makes one revolution in 30 seconds. If thus the contacts of the rheostat are distributed over two-thirds of the periphery, the regulation between the extremes will occupy but 20 seconds. Of course, a more rapid regulation may be obtained if desirable.

Automatic Clutch and Contact for Arc Lamps.—*The Electrician*, of London, describes the Acton-Worsley automatic clutch and contact for arc lamps, which is a device designed for the easy manipulation of arc lamps suspended from brackets or lofty ceilings, so that by means of a winch and suspension cord they may be lowered to the ground to be trimmed and hauled up again into position without an unsightly festoon of cable. The gear is made to support a weight of over 1 cwt., and is so arranged that when hauled up into position the whole weight of the lamp suspended from the gear is taken off the cord and supported by hooks. There are two parts—the upper part, with a hooded dome, and the lower part, on to which the lamp or other article is attached. All the movable parts are attached to this lower half, so that if anything should go out of gear at any time, it can be lowered for attention at ground level. The device for hooking is very simple, consisting of two large hooks which, by gravity, come into contact with

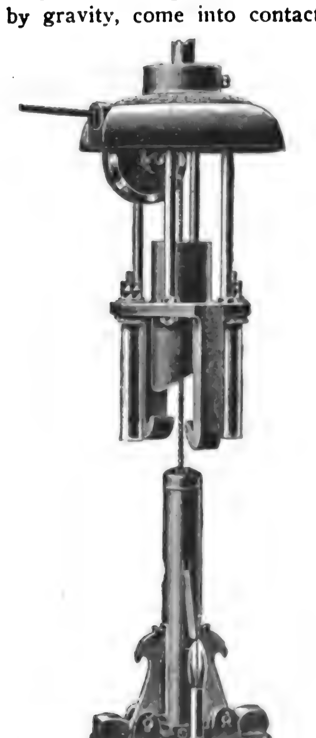


FIG. 2.—ARC LAMP CLUTCH.

two other hooks hanging from the top parts and a small catch-piece which is loosely fixed midway between the two movable hooks. This catch-piece only comes into play when the lower part of the contact gear is hauled up into position. When it is necessary to lower the gear, a slight turn of the winch in the direction of hauling up is made, when the hooks disengage, and the lamp can be lowered to the ground.

The contacts are large, of the plug type, and self-cleaning. A neat cylinder effectively protects the gear from the weather. There are no springs or delicate parts to get out of order.

Electric Transmission of Parcels.—A recent issue of *L'Industrie Electrique* contains a description of an electrically-operated plant for the transmission of parcels and mail matter at high speeds which is now being experimented with by the Société des Chemins de Fer Electro-Postaux. The runs have been made on a circular track of 500 metres (1640 ft.) radius. The car used is 28.8 ft. long by 3½ ft. wide, and weighs 6¾ tons. It has provision for carrying ½ ton of parcels, so long as these do not occupy a space of more than 70 cubic feet. The speed aimed at is 156 miles an hour, and this has been readily attained on trial. The car runs upon a single rail, but is guided by guide-wheels bearing on opposite sides of a special guide-rail. There are two driving-wheels driven by belting from three-phase motors taking current at 1000 volts and at a frequency of 40 cycles per second. It has been found that the speed of 156 miles an hour was attained in five minutes from starting, and on the current being cut off the vehicle came to rest again after the same lapse of time. The retardation on cutting off the current can, however, be greatly increased by means of wind resistances, which are folded down flat on the car when it is running, but are opened out automatically when a certain string is cut by a fixed knife interposed in the path of the car. Forced lubrication is adopted for the principal bearings, which are fed from an oil-pump coupled to a direct-current motor driven by a small battery of accumulators mounted on the car. No details as to the current consumption of the main motors are given.

Some Recent Electrical Patents

Discount Meter.—The increasing application of the principle of a sliding scale of meter rates graded according to the total consumption by a customer of a central station, has led to the development of several forms of meters intended to take care of the sliding scale feature automatically. One of the latest ideas of this general class is illustrated diagrammatically by Figs. 1 and 2 herewith, and has been patented by Mr. Thomas Duncan, of Chicago, Ill. The inventor's method consists broadly of varying the speed of the meter by means of an automatic regulator which varies the resistance of the shunt circuit of the meter and thereby varies its speed when the load exceeds a certain value. Fig. 1 shows one method of doing this, in which sections of a resistance coil, 17, are cut out and into circuit automatically by a solenoid, 19, the plunger of which carries a finger which engages with flexible terminals, 18, connected to the resistance. When the maximum predetermined load is on, the plunger is held down in the position shown, and all of the resistance is inserted in the shunt circuit of the meter, giving its minimum rate of speed per unit of energy. At lighter loads the solenoid plunger is held at higher positions, cutting out more or less of the resistance, 17, and varying the speed of the meter accordingly. The invention also includes an arrangement for giving the consumer a flat discount from his bill by adjusting the speed of the meter. This consists of a second resistance, 13, sections of which are cut in and out of circuit by means of the switch, 14, according to the discount which it is desired to give the customer, the object of this arrangement being presumably to avoid the use of discounts in making out the bills. The supplementary field-winding, 15, is also tapped to a switch, 16, in order that this winding may be strengthened in proportion to the weakening effect when resistance is inserted by means of the switch 14. For example, if no discount is given the switch, 14, rests on the zero contact and the switch, 16, is also set at the zero contact, which gives the meter its normal shunt field. If 10 per cent discount is to be given the switch, 14, is set as shown in the diagram, inserting part of the resistance. To compensate for this the switch, 16, is set on the 10 per cent button, putting in circuit more field winding, which compensates magnetically, but does not counterbalance the resistance inserted by the switch, 14. The meter, therefore, has its normal starting torque with the reduced current flow in the shunt circuit. Fig. 2 illustrates an elaboration of the idea. In this arrangement the automatic grading resistance, 17, is connected in series with the shunt field coils, 19, which act differentially or in opposition to the main field coils, instead of being in series with the armature, the armature being in series with the fixed discount resistance, 13, and another shunt field winding, 15, which is adjustable as in the previous case by means of the switch, 16. The differential winding, 19, is prevented from acting too soon by means of the auxiliary contacts, 20, in series with the winding. These contacts are open, as indicated in the diagram, so long as the load does not exceed the critical point beyond which the sliding discount is to be applied.

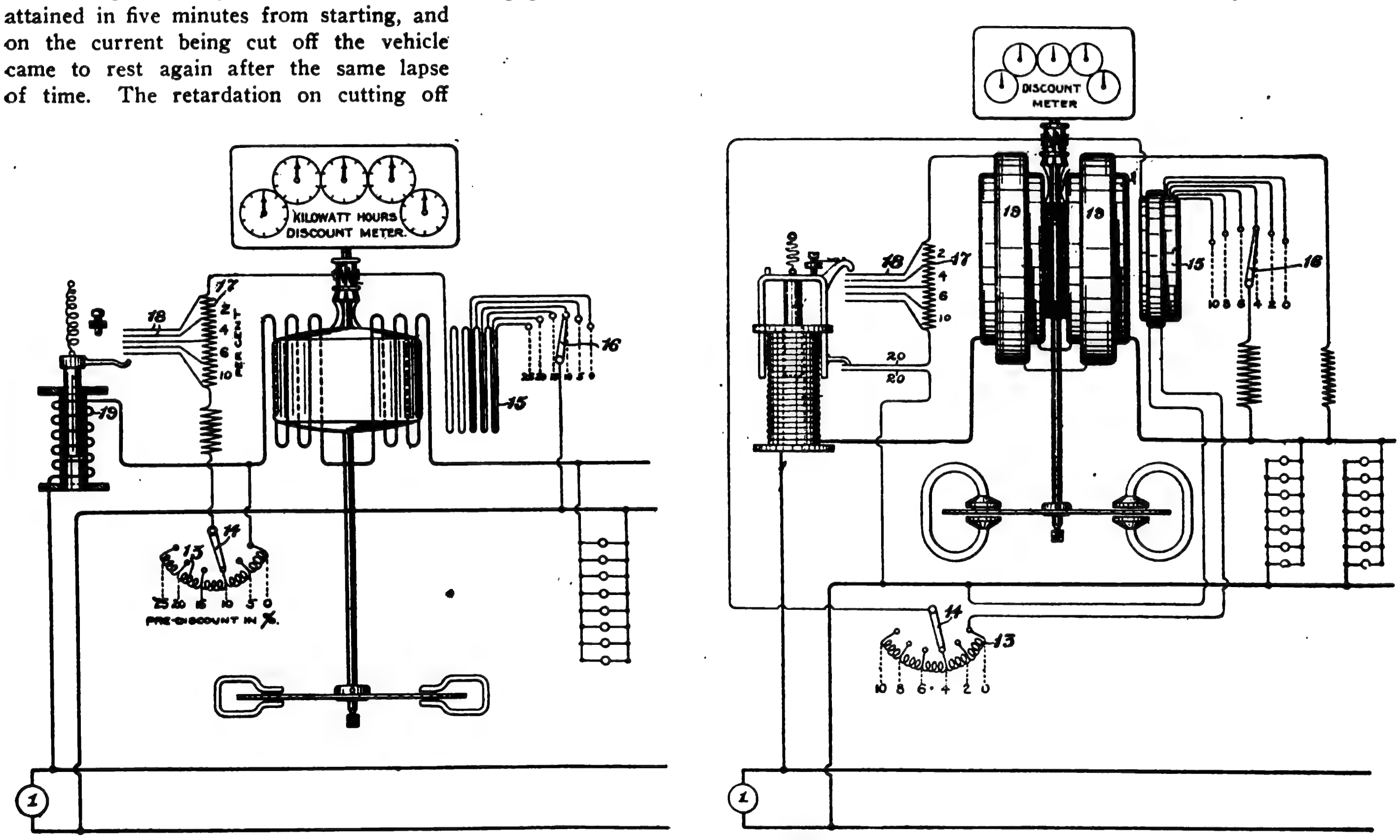


FIG. 1.—DUNCAN DISCOUNT METER.—FIG. 2.

When it does exceed this point, the solenoid closes the contacts, 20, putting the differential winding, 19, in circuit, and further increases in the load cause the solenoid to cut out more and more of the resistance, 17, increasing the demagnetizing action of the field winding, 19. Patents 796,038 and 796,039.

Automatic Regulator for Alternating Current Motors.—It is a fact familiar to those who have followed the development of the repulsion motor that the torque of the machine may be varied by shifting the position of the brushes which short-circuit the armature or rotor winding. Mr. George H. Hill, of Schenectady, N. Y., proposes to utilize this feature of the repulsion motor for the purpose of accelerating its speed automatically, from standstill to full speed, his general arrangement being indicated diagrammatically by Fig. 3. In the diagram the stator winding is represented by *S* and the rotor winding by *R*; the rotor winding is connected to a commutator in the usual way, but for simplicity this is omitted and the brushes, *b*, are shown in direct contact with the winding. These brushes are mounted in a brush-holder ring, *B*, which is adjustable around the axis of the machine and is connected to a similar ring, *e*, by means of a belt, *H*, so that when the ring, *e*, is rotated the brush ring *B* follows its movement. The controlling ring, *e*, carries a coil, *E*, which is arranged in inductive relation to stationary coils, *CC*, the latter being in series with the stator winding. The polarities of the two sets of coils are such that when they are energized the coil *E* tends to turn counter-clockwise, which tendency is opposed by the weight *W* attached to the arm *F*. The drawing shows the equipment as arranged for use on an electric car, so that the ground connections, *GG*, represent one terminal of the supply system; the main terminal of opposite polarity is the wire *T*. When the apparatus is in position of rest, the arm *F* is raised to its horizontal position, where it is held by the latch, *f*; in this position it raises the bridge, *I*, and closes the circuit from the upper ground terminal through the solenoid, *A*, to supply source, *T* (when the switch *s* is closed), which is of the same polarity as the main supply terminal, *T*, but not necessarily of the same voltage. The switch, *s*, being closed under these conditions, current will flow through the solenoid, *A*, and the brush, *I*, to the ground connection which is a common return for both supply sources. The solenoid, *A*, will then raise its plunger and bridge the contacts, 3, 4 and 5, 6. The contacts 3, 4 close the torque circuit to the stator of the machine, and the contacts 5, 6 close the return connection between the solenoid, *A*, and the ground, so as to make the solenoid independent of the bridge, *I*. With the arm, *F*, horizontal the short-circuiting brushes on the rotor commutator are in the position of zero torque and the motor, of course, does not start up. The magnetized current, however, through the stator winding passes through the solenoid, *D*, which releases the latch, *f*, and allows the lever, *F*, to be drawn down by the weight. A shunt current passes from the main terminal, *T*, through the movable coil, *E*, to the ground, and this restricts the downward motion of the arm *F*, and consequently, the circular motion of the brush ring, *B*. When the arm, *F*, falls to a position where the magnetic pull of the coil, *E*, balances the weight, *W*, the brushes will have reached a position where the motor has sufficient torque to start up. As the motor speeds up and the counter e.m.f. in the stator winding increases, the current in the coils, *C*, *C*, will decrease, allowing the weight, *W*, to pull the arm, *F*, still further down, carrying the brushes further around toward the point of maximum torque and increasing the speed of the motor still further. This will continue until the motor is running at full speed and the opposing forces in the regulator are in equilibrium. From the foregoing it will be evident that the regulators operate to produce practically a constant current flow through the stator winding of the motor. The regulator is provided with an auxiliary set of stationary coils, *c*, *c*, which are short-circuited when the plunger of the solenoid, *A*, goes up. When the switch, *s*, is open to shut the motor down the solenoid, *A*, is de-energized, of course, and drops its plunger, opening the two paths of contact. This removes the short-circuit around the auxiliary coils, *c*, *c*, and they then receive current from the main terminal, *T*, and through the bridge piece, *I*, this current passing to ground through the movable coil, *E*. The auxiliary coils and the movable coil, *E*, rotate the ring, *e*, raising the lever, *F*, until it is held in a horizontal position by the latch, *f*. In this position the bridge, *I*, is lifted from its bottom contacts, opening the connection between the main terminal, *T*, and the auxiliary coils, *c*, *c*. Patent 795,392.

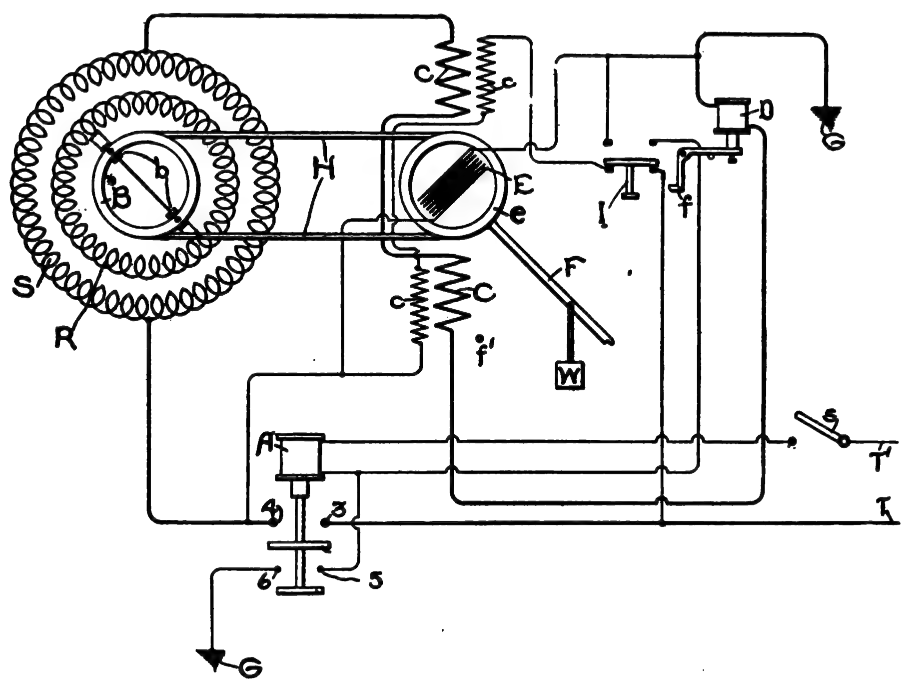


FIG. 3.—AUTOMATIC REGULATOR FOR ALTERNATING-CURRENT MOTORS.

NOTES.

Western Association of Electrical Inspectors.—W. S. Boyd, secretary of the Western Association of Electrical Inspectors, announces that a meeting of this association will be held in rooms 1232-4-6, National Life Building, Chicago, at 10 a. m., October 5 and 6.

Western Society of Engineers—The first session of the meeting of the electrical section of the Western Society of Engineers will be held at the society rooms in the Monadnock Block, Chicago, Friday evening, October 13. J. R. Cravath will read a paper illustrated with numerous lantern slides, on "Do We Need Better Illuminating Engineering?"

Consumption of Electricity in Boston.—Since the advent of the electrical sign in Boston, the amount of electrical current consumed has had such a notable yearly increase that Boston now leads the world in consumption of electric current per capita; that is, in the number of electric light units for each man, woman and child of her population.

Automobile Exhibition in New York City—The Sixth Annual Exhibition of the Automobile Club of America will be held in the Sixty-ninth Regiment Armory, Lexington Avenue, 25th and 26th Streets, New York City, January 13 to 20, 1906. The exhibition will be under the direction of the Exhibition Committee of the Automobile Club of America, 753 Fifth Avenue, New York City.

Ohio Society of Mechanical, Electrical and Steam Engineers.—The annual meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers will be held at Canton, Ohio, November 17 and 18. A number of interesting papers are scheduled for presentation and some proposed changes in the

constitution are to be acted on. Mr. Richard H. Probert, of Akron, is president of the society, and Mr. Corwin J. Miller, of Canton, is secretary.

Fire at Niagara Falls.—Fire started on the night of September 9 in the wire tower of the Niagara Falls Hydraulic Power Company. The fire was upon the wires owned and operated by the Pittsburg Reduction Company. The wires pass through a gate house over one of the waterways and damaged it to some extent, although no damage was done to the power station. The city was left in darkness temporarily, as the power was shut off for the safety of the firemen engaged in extinguishing the burning insulation. Power was delivered to the other customers of the company as soon as the firemen left the building.

Madison Square Garden Electrical Show.—An electrical show will be held at Madison Square Garden, New York City, from December 11 to 23, inclusive. The Director of Exhibits is Dr. George F. Sever, of Columbia University. The office of the Exhibit Committee is at 26 Cortlandt Street, New York City. Among others the following well-known firms have already selected their space and are busy preparing attractive exhibits: National Carbon Company, Harry M. Stevens, Eastern Carbon Works, Joseph Goldfinger, New York Telephone Company, Chicago Pneumatic Tool Company, Electro-Dynamic Company, General Storage Battery Company, G. M. Gest and Ovington Manufacturing Company.

Central Station Advertising.—President Blood, of the National Electric Light Association, has appointed Paul Spencer, of Philadelphia, John F. Gilchrist, of Chicago, and Joseph E. Montague, of Niagara Falls, as a committee to co-operate with the advertising committee of the American Association of Incandescent Lamp Manufacturers in the matter of assisting central stations in the adoption of advertising methods that will result in increased business. It will be remembered that the Lamp Manufacturers' Association made an offer to the National Association at its Denver meeting of $10,000 to be expended for the above purpose, and the offer being accepted this committee has been appointed to complete plans for the work

Welfare Work Medal—The International Exposition of Social Economy, held at Liege, Belgium, has awarded the New York Telephone Company a silver medal in recognition of its welfare work among its employees. The New York Telephone Company has seventeen exchanges in Manhattan and employs about 2,500 operators. In each of the exchanges a suite of rooms has been set aside for the exclusive use of the young women. These suites include locker rooms where each girl may keep her effects under lock and key, a general sitting room supplied with the latest magazines, and a sick room supplied with an emergency medical outfit. In a thoroughly equipped room tea and coffee are served free of charge. The quarters are in charge of a matron who looks after the comforts of the girls.

The Boston Edison Company and the Newspapers.—A vigorous advertising campaign is being carried on in the Boston newspapers by the Edison Electric Illuminating Company of that city. The amount of space taken daily is not large, but the advertisements are placed in unusually conspicuous places and are exceptionally well worded, as the following sample taken from the first page of the Boston *Evening Transcript*, next to the News Summary, shows:

ELECTRICITY

costs you nothing when the current is not turned on. When you want it for power you turn it on and—there you are. You use what you need; you pay for what you use. With steam, cost goes on as long as there 's fire — and after, for there 'll be the ashes to dispose of. And those coal bills!

Have you learned to be power-wise? It will cost you nothing to learn fully. Write, or telephone, our Contract Agent. If you prefer, call to see him.

The Edison Electric Illuminating Company of Boston, 3 Head Place.
(**1)

Central station men are gradually coming to realize that in order to increase their productive output to the utmost, active measures must be taken to enlist the interest of the public in the question of electrical supply. The Boston Edison Company also places signs upon new buildings which it is to supply with current, following the custom of heating and other contractors in such work, in addition to its newspaper and exhibition room activities.

Electrical Exhibition in Chicago.—A company has recently been organized in Chicago to hold an electrical exposition in which electrical machinery, appliances and apparatus in all branches of the industry will be shown. The exhibition will be held in the Chicago Coliseum January 15 to 27, 1906. It will be for the information and instruction of the general public in the various uses to which electricity is applied, and will also interest the electrical fraternity. The name of the company is the Electrical Trades Exposition Company, and includes as stockholders seventy-five of the leading electrical men of Chicago. The officers are as follows: Samuel Insull, president; E. B. Ellicott, Charles E. Gregory and E. B. Overshine, vice-presidents; John J. Abbott, treasurer; Stewart J. Spaulding, secretary; Thomas R. Mercein, general manager. The directors are: Samuel Insull, Edward B. Ellicott, T. P. Gaylord, James Wolff, H. B. McMeal, C. E. Mitchell, Homer E. Niesz, E. B. Overshine, G. H. Atkin, Stewart Spaulding, Charles E. Gregory, G. E. Kohler and G. B. Foster.

Central Station Statistics.—The Census Bureau has just published a report on central electric light and power stations for the year ending June 30, 1902, prepared under the supervision of W. M. Steuart, chief statistician for manufactures. It is the third of a series of reports on the operation and utilization of electric current, and in addition to the text, which was prepared by T. C. Martin, New York City, expert special agent, there are elaborate tables and an interesting series of illustrations. The chapters of text discuss respectively the scope and method of the investigation, financial operations, employees, salaries, physical equipment, output of stations, franchises, and the history and development of electric lighting. The statistics do not include isolated electric light and power plants. For convenience, the various electric stations have been divided into two grand classes—those operated by individuals and corporations and those operated under municipal control. Each of these classes is subdivided into those doing a purely electrical business and those operated in connection with other industries. Further subdivisions have been made, one being based upon the population of the place in which the station is located, and the other upon the horse-power capacity of the generating apparatus of the station. Before 1902 there were in the United States 3,620 central electrical stations, 22.5 per cent. of which were municipal stations. The largest number of stations was in Illinois, followed by Pennsylvania, New York, Ohio, Michigan, Indiana, Iowa and Wisconsin in the order named. The New England states were well supplied with stations. Massachusetts reported the largest number, followed by Maine, Vermont, New Hampshire and Connecticut. Among the Southern states Texas led, with Kentucky, Tennessee and Georgia following. Of the Western states, California reported the largest number of stations, Colorado, Washington, Oregon and Montana being next in order. The power plant equipment showed 5,930 steam engines with 1,379,941 horse-power, and 1,390 water wheels with 4 8,472 horse-power. The generating plant equipment showed 3,823 direct-current constant-voltage dynamos with 442,446 horse-power, 3,539 direct-current constant-amperage dynamos with 195,531 horse-power, 5,122 alternating and polyphase dynamos with 987,003 horse-power. The line construction had 107,263 miles of mains and 17,880 miles of feeders. For the service line equipment there were 582,689 meters, 575,004 of these being mechanical and 7,685 chemical. The aggregate of arc lamps of all classes was 385,698, of which 86.8 per cent were operated from private stations and 13.2 per cent. from municipal stations. In addition to the light supplied by central stations, the street

railways operating electric lighting stations reported 33,863 arc lamps, making a total for the United States of 419,561. The average output of current per day for all stations was 6,960,783 kilowatt-hours, making a total for the year of 2,507,051,115 kilowatt-hours. Among the private stations the totals for New York are at the head; among the municipal stations, Illinois leads.

Association of Edison Illuminating Companies.—The 26th convention of the Association of Edison Illuminating Companies was held at Bluff Point, Lake Champlain, N. Y., September 12, 13 and 14. The meeting was well attended by delegates from all parts of the country, and following its usual practice, the Association held two sessions daily—morning and evening. The rule of the Association of sitting with closed doors was adhered to, and whatever information was divulged was given through a press committee. Reports of the executive committee, meter committee, storage battery committee, lamp committee, National Code Committee and steam turbine committee were presented Tuesday morning and were followed by a paper on "The Practical Operation of the Nernst Lamp," by W. T. Morrison, of New York. Other papers presented were as follows: "The Use of Small-Sized Carbons in Alternating-Current Arc Lamps," by G. N. Eastman, of Chicago; "A New Rotative Test Meter," by W. J. Mowbray, of Brooklyn; "Experiences with Tests on All Kinds of Lamps for the Past Year, Including Nernst Lamps," by Dr. C. H. Sharp, of New York; "Practical Experience with Steam Turbines," by J. A. Radford, of Chicago; "Improvements in Steam Turbines," by W. L. R. Emmet, of Schenectady; "Methods of Starting up Large Interconnected Systems Quickly After Partial or Total Shut-Downs," and "Instruction and Training of All Operating and Construction Men Who Work on High-Potential Apparatus and Connections," by W. F. Wells, Brooklyn; "Relative Advantages of 25 and 60 Cycles, Seen from the Standpoint of the Central Station Rather Than the Power Transmission System, Pure and Simple," by P. Torchio, of New York, and W. C. Eglin, of Philadelphia; "Magnetite Lamps and Mercury Vapor Arc Lamps and Mercury Arc Rectifiers in Connection with Electric Light," by C. P. Steinmetz; "The International Electrical Congress at St. Louis," by J. W. Lieb, Jr., of New York; "Coal Handling and Storage of the Edison Electric Illuminating Company at the South Boston Station"; "Notes on Sales of Electric Power," by E. W. Lloyd, of Chicago; "The Relation of the Central Station to the Motor-Driven Refrigerating Machine," by G. W. Goddard, of Philadelphia; "The Relative Merits of Discharging Batteries in Edison Systems Through Reversible Boosters and Through End Cell Switches," by Gerhard Gottling, of Boston. Mr. Joseph B. McCall, of Philadelphia, was re-elected president and will thus serve a third term.

CENTRAL STATION ENGINEERS—XII.

Charles R. Huntley.

Charles R. Huntley, second vice-president of the Buffalo General Electric Company and one of the pioneer electrical men, was born in Winfield, Herkimer Co., New York, on October 12, 1854. His early education was received in the district school and afterwards when his parents moved to Utica, New York, he entered the Utica Academy. After graduating he entered a hardware firm where his first business training was acquired, and he subsequently became identified with the firm of Remington & Sons, manufacturers of the Remington guns and typewriters of that name. Late in the 70's he settled at Buffalo, New York, and in 1878 became general agent of the

CHARLES R. HUNTLEY.

Standard Oil Company, of Pennsylvania, and remained with that corporation in their oil interests to 1883. For the next five years he conducted a brokerage business in Bradford, Pa., and in 1888 he again came to Buffalo as the representative of his former employers, looking after their interests in the Brush Electric Light Co., which subsequently became the Buffalo General Electric Company, of which he is now, and has been, for several years the general manager. Mr. Huntley possesses unmistakable lines of strength. He knows how to juggle with minds and figures; knows how to plan and win, and above all, knows how to handle men. A thorough knowledge of human nature is his, and this combined with business keenness and pleasing social manners has contributed much to his success. He was one of the most valued employees of the Standard Oil Company, in whose service are enlisted many strong and capable men. Mr. Huntley has served as chairman of the Executive Committee of the National Electric Light Association and was elected president at the Providence Convention held in February, 1891. He is a prominent citizen of Buffalo, and has been identified with all progressive movements.

New Haven Railroad Adopts Single-Phase Motors.—The New York, New Haven & Hartford Railroad Company has contracted with the Westinghouse Electric & Manufacturing Company for twenty-five locomotives to be used for high-speed passenger service. The motors will be of the single-phase, commutator type, which can be used with direct current, so as to operate over the section now being installed by the New York Central & Hudson River Railroad. The New York, New Haven & Hartford Railroad utilizes the tracks of the latter company between Woodlawn and the Grand Central Depot in New York City, and for a time the electric service will be confined to this section. Each locomotive will have four gearless motors permanently connected, two in series. On direct current the motors will be operated in series parallel and on alternating current by voltage control. Each motor will be capable of developing 400 horse-power on direct current.

American Electrochemical Society.—The eighth general meeting of this society was held at Bethlehem, Pa., September 18 and 20. The professional session was held in the chemical laboratory of Lehigh University and some twenty papers were presented. Among those which were of special interest to electrical engineers was one by Lawrence Addicks, which discussed the precautions which must be taken in installing ammeters for measuring very heavy currents, such as used in electrolytic plants, and a paper by Dr. M. Tosh on "Insulating Plants and Their Relation to Electric Traction." The president of the society, Dr. Bancroft, delivered a very interesting experimental lecture on "The Chemistry of Electrochemistry." There was also a lively discussion on the use of the electric furnace in the metallurgy of iron and steel. Some excursions which were planned to points of interest in the neighborhood were somewhat spoiled by the inclement weather, but the visits to the zinc works and the Bethlehem Steel Company's plant in South Bethlehem, as well as to the large cement works in Nazareth, were greatly enjoyed.

Illinois Electric Association.—The Illinois State Electric Association will hold its annual meeting in Peoria, Ill., October 5 and 6. The meetings will be held at the National Hotel, where arrangements have also been made for exhibits. Several interesting papers will be read on various subjects. Important questions will be brought up for discussion, and an entertainment committee will look after the pleasure and comfort of members and visitors. Mr. D. Davis, of Litchfield, is secretary of the association.

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CONTENTS.

Compound Engines in Isolated Plants.

One of the most noteworthy features of isolated plant practice to-day is the increasing use of compound engines under conditions which but a few years ago would have been considered unfavorable to anything but single expansion machines. Most of these engines are of the non-condensing type, and they are operated in the winter season with either the vacuum or gravity heating system, often in preference to the single-cylinder units which are frequently found in the same plant. The greatest economy from compounding is naturally realized in the summer season, and in cases where the cost of fuel is high; as a general rule also, when the engine is not an auxiliary power unit the coal saving to be expected from using two expansion stages will be realized every time under good management.

The main point is always to operate the compound-unit within its economical range, say from 50 per cent load to full load. At light loads the gains fall off quickly, although steam turbine advocates make claims for a remarkably slow rate of economy loss as the output decreases. If these are vindicated in practice there ought to be a good field for the turbine-generator in isolated plant work as soon as the manufacturers bring out turbines somewhat larger than the direct-current train lighting sets which are now becoming so widely specified in steam railroad service.

Recent designs of compound engines for isolated plant service are remarkably compact, the duplex compound with one cylinder above the other taking up no more floor space than the simple engine of the same capacity. The anticipated increase in maintenance charges has been so small as to cause little or no criticism. The tandem-compound requires a little more floor space, but not enough to cause any anxiety, unless it be in marine work, where every square inch must be utilized. The cross-compound allows a little more flexibility than the tandem and the duplex, and it insures a better distribution of cross-head strains in case it is necessary to run "on one leg." In the plant of a well-known office building in New England a duplex compound engine of 100 kilowatts capacity and a simple engine of the same rated output were recently run upon alternate days for about a week on an electric elevator load of heavy fluctuations, the result being an economy in coal of about 25 per cent in favor of the former. At full load an economy of 30 or 35 per cent is not uncommon, and the increase in fuel consumption only about one per cent to raise the boiler pressure from 80 to 125 pounds. The compounding question is certainly worth looking into, whether or not one decides that the use of such engines warrants, say, a 30 per cent increase in first cost and fits in with the operation of the heating system on all-the-year round economy.

The Expanding Field of the Small Motor.

An impressive point in connection with every exhibition of mechanical appliances and machinery held in these days is the all-around usefulness of the small motor, particularly in the sizes below five horse-power. It often happens that the apparatus shown is designed to be operated by steam, gasoline, oil or water under conditions which are either impossible to duplicate or intolerable on account of the fire risk and atmospheric vitiation in a large hall or pavilion. In such cases electricity solves the problem perfectly, and the displayed mechanism travels its prescribed cycle at any convenient speed desired by means of the simple application of an inconspicuous, cleanly, flexibly arranged and efficient belted or direct-connected motor. Given such an installation, the exhibitor's energies are no longer spent watching for trouble in his moving display; he is free to concentrate his attention upon his visitors and show to the best advantage the ins and outs of his exhibit. Probably in no other way could the operation of gearing and valve motions in automobiles, power boats and heat engines in general be as well shown in detail. The use of the electric fan to increase the physical comfort of exhibits in crowded halls is also worth mentioning.

As a matter of fact, the uses of the small motor are now almost beyond enumeration. In the single field of retail advertising the electric motor can be applied almost without limit. The store windows of every progressive city are alive with devices driven by electric power. In the laboratory the motor-driven "centrifuge" offers an easy method of separating solids held in suspension from their respective liquids; grinders, stirrers, crushers, gas extractors and pneumatic blowers are readily driven by small motors; the dental drill and tiny surgical bone saw are equally dependent upon these prime movers. Musical instruments, phonographs and battery-driven fans for the sick room unsupplied with central station current merely suggest the expanding range of the small motor field.

There is often a tendency on the part of central station men to belittle the very small motor and other relatively minute applications of current to humble purposes. In the light of experience this is certainly poor judgment, for, although the revenue that the central station derives from such sources is insignificant in comparison with its income from large consumers, each new application of electricity in a community widens the public's appreciation of its adaptability to the affairs of life and in the long run opens the way toward larger commercial success.

Alternating-Current Motors in Shop Practice.

In the selection of motors for factory driving the question often arises as to the availability of alternating-current types for the work in hand. Since the early development of motors capable of driving machine tools naturally proceeded along direct-current lines, the opinions held in many quarters to-day are based on failure to realize the extent to which alternating-current machines have been applied in shop practice, or their particular field of usefulness.

There is no question that the direct-current motor has perfectly solved the problem of machine-tool driving under the usual circumstances of factory operation. For work requiring speed changes in increments of 10 or 15 per cent over wide ranges in order to reap the full benefit of high-speed machine-tool steels, the direct-current motor appears to have no superior. Probably the day is not far distant when the designer of alternating-current motors will produce equipment capable of much wider speed variation than present market types exhibit. Nevertheless, the direct-current motor has a strong grip upon the variable-speed field of application, except in installations where the presence of water, explosive gases, metal dust, and other foreign substances make the use of a commutator dangerous or otherwise objectionable. The use of alternating-current motors in such cases entails the employment of some external speed-changing device, for both the induction and synchronous types are essentially constant-speed machines. Fortunately high-speed tool steels are usually operated under conditions not unfavorable to the installation of direct-current equipments. Convenience of manipulation with little effort and loss of time on the part of the workman are essential to the successful use of steels capable of taking cuts at the rate of 100 to 200 feet per minute, but at the present time it is very hard to find any thoroughly satisfactory mechanical variable-speed device on the market. Direct-current control gives the best modern results.

The strong points of the alternating-current motor, as we have pointed out before, are its simplicity, its ability to carry heavy overloads without damage, and its low cost of maintenance. Uniform equipment is a boon in every industrial plant, and the use of a single type of motor in a factory already equipped with an alternating-current isolated lighting plant is a most desirable course. The new shops of the United Shoe Machinery Company, at Beverly, Mass., for instance, illustrate most admirably the advantages of simplifying the electrical installation. Turbine-alternators supply current to the lighting circuits and to induction motors throughout the buildings, not a direct-current machine being used in the shops. The problem of machine driving in this case, however, did not preclude the use of constant-speed motors.

It is not so much a question of group or individual driving, in considering the alternating-current motor for a shop installation, as it is a matter of the speed range required by individual machines. If the work done by a machine or a group of machines does not require relatively fine gradations in speed, the alternating-current machine will handle the situation admirably, even though extremely wide variations in power may be required. Planers, slotting machines, punches, milling machines, shapers, and other equipment in which reciprocating motions are employed generally impose heavy momentary overloads which are prone to cause flashing at the commutators of direct-current motors, while alternating-current motors of the same rated capacity give little or no evidence of the strain. The latter type cannot run away as do compound or shunt-wound motors in case the field circuit is accidentally opened; attendance is reduced to keeping the oil wells filled and to seeing that the rings are operating properly; repairs are easily made in the rare intervals when they are necessary, and in the smaller sizes of motors the starting box is eliminated. The entire range of group driving at constant speed and of individual driving, where the conditions are well known and the quality of material and tool steel fixed, gives the alternating-current motor a field of service on equal terms with its older rival. The fire risk and the element of personal danger both are reduced in a well-designed and installed alternating-current layout. In large plants the advantage of distribution at higher potentials than are feasible with direct-current will frequently decide the choice in favor of the alternating-current motor.

The Central Station and the Small Consumer.

One of the greatest mistakes that a business house can make in these days of keen competition is to discriminate unfairly between its customers. While it is only just that the wholesale buyer shall receive discounts greater than those accorded the small purchaser, it is very bad policy to treat the latter as though his transactions were of no importance. Most progressive retail establishments realize this point, with the result that from the department store to the bank the small account receives the same consideration as the large one.

In the central station field there is still a tendency on the part of many managers to look upon the small user of power as a customer of little consequence. On this account very little energy is expended by such managers in seeking new business of the smaller kind. Often the solicitor's time is fully occupied with larger propositions, and there is a feeling that it will not pay to increase the force simply to persuade Jones to run his little back-alley carpenter shop by a 3-h.p. motor or Smith to install a couple of electric fans in front of his soda fountain. Why should the company pay the cost of educating old Dr. Phosphorus up to the point of putting half a dozen 16-c.p. lamps into his dingy, gas-illuminated den which has long been blackened by the fumes of forty years' chemical experiments? Very likely some of these "small fry" will buy a couple of dollars' worth of current in a month, and "it is actually a question if it will pay to tie up the equipment."

Such a point of view as this belongs in the heathen lands where life proceeds from day to day on the basis of the cocoanut and the loin cloth. It has no place in the central station industry, where every manager is in business for all there is in it, and therefore is eager to increase his load by every legitimate means. To be sure, there is often small profitable revenue gained from the customers whose requirements are very limited, but it should not be forgotten that when a customer has learned to appreciate the advantages of electric lighting and electric motors over other forms of illumination and power he is pretty sure to enlarge his facilities sooner or later as his business expands, and usually encourages others to follow suit.

CONSTRUCTION OF A JUMP SPARK COIL.

The successful construction of a jump spark coil for gas engine ignition purposes is rather difficult for an amateur because of the high-grade insulation which is indispensable to satisfactory operation. The mechanical part of the construction is simple to the last degree. The data given herein will enable any fairly capable amateur to build an excellent coil provided he is sufficiently patient and painstaking to insure proper insulation; several coils have been constructed from the data here given and

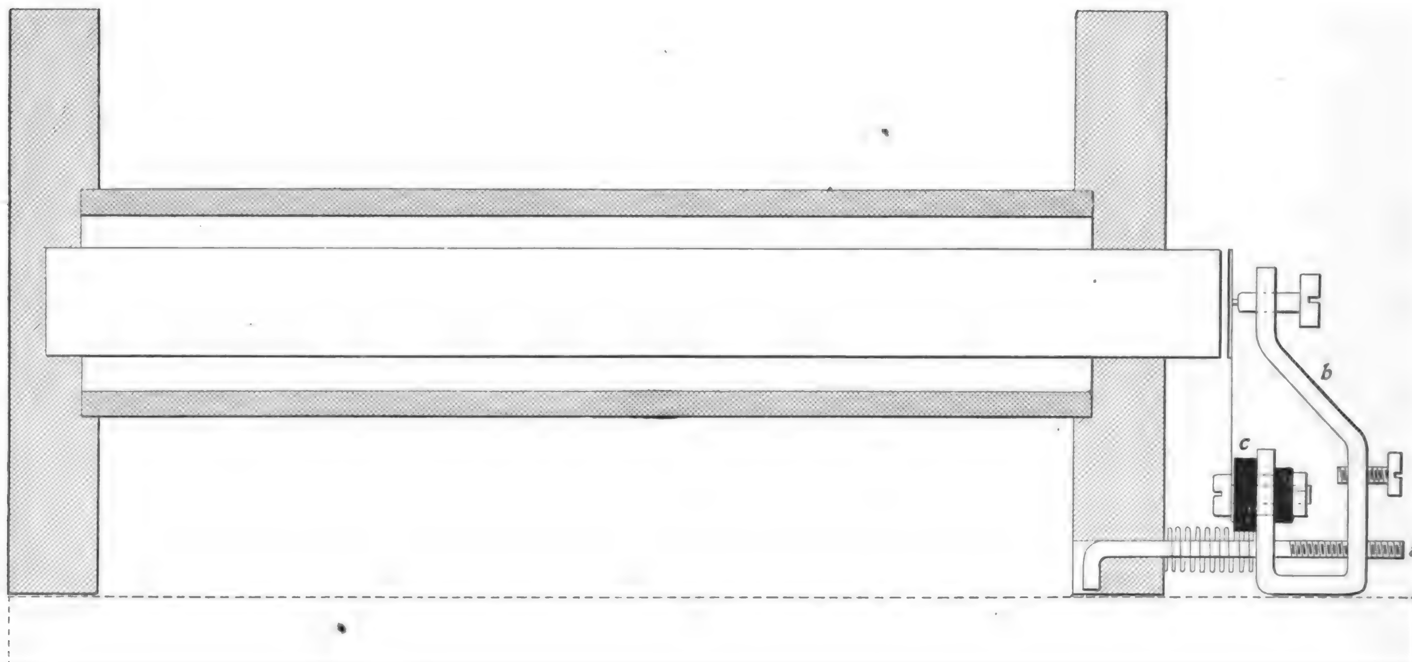


FIG. I.—SECTIONAL ASSEMBLY DRAWING OF JUMP SPARK COIL.

all of them excepting one have been in continuous and perfectly satisfactory operation ever since they were finished. The one exception failed because it was not properly insulated.

The core is built up of No. 22 soft iron wires 8 in. long; these must be thoroughly annealed after being cut to length. The bundle is 3/4 in. in diameter. The core is assembled in the heads, the wires being "coddled" into position when the core approaches normal size, and the final wires being inserted one by one until no more can be got in. As the sectional assembly drawing, Fig. 1, indicates, the rear end of the core does not pass through the back head, but sets into it 3/8 in.; it does pass through the front head and must be tied tightly with fine linen thread as close to the head as possible so that the head may be removed and replaced without trouble. The core must project 3/8 in. beyond the outer surface of the front head.

The heads must be made of hard wood 5/8 in. thick. Each head is 4 in. square and counterbored 1/8 in. deep on the inner face to take the rubber tube which separates the primary and secondary windings This tube is 1 3/16 in. bore with wall 3/16 in. thick, so that its outer diameter is 1 9/16 in.; it is 6 7/8 in. long, and the ends must be perfectly square with the bore (at right angles to it). After the heads have been shaped up and bored, they must be boiled in paraffine; this is accomplished by simply melting paraffine wax in a vessel and immersing the heads in the melted wax, the latter being kept boiling for an hour. The heads are then to be taken out and allowed to cool in clean surroundings.

After assembling the core in the heads, the latter being set exactly 6 5/8 in. apart, the core should be taped with a good grade of adhesive insulating tape; high insulation here is not essential. Then the primary coil should be wound on, starting the first layer at the front head with the end of the wire projecting two or three inches through a hole in that head close to the core. This coil consists of two layers of No. 16 double-cotton-covered magnet wire, the turns being wound as closely as possible, of course. The finishing end of the wire should be tied

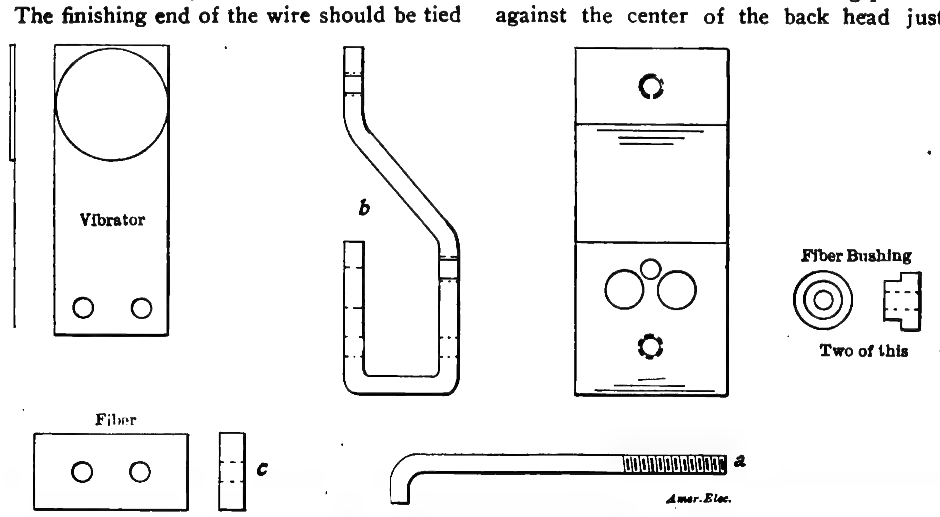


FIG. 2.—DETAILS OF SPARK COIL.

down temporarily to the coil. The front head is then pulled off the core, taking care that the starting end of the primary wire pulls through the hole in the head and does not unwind the inner layer. The rubber tube is then slipped over the primary coil and seated in the counterbore in the back head, and the front head is put back in place, this time permanently. The two ends of the primary winding must be threaded through holes in the front head as it is put back, and these ends should be protected by woven cotton sleeves, such as those used on the leads of direct-current dynamo armature windings. Just before pressing the front head "home" against the end of the rubber tube, the end of the primary coil should be lightly varnished with shellac, including the terminals and their sleeves; this will stiffen the end convolutions of the coil and tend to prevent tearing them down if it should be necessary at any future time to take off the front head again.

The core should then be chucked in a lathe, the front end being held in the chuck and the tail center of the lathe being pressed against the center of the back head just enough to indent the wood and keep it central. The supporting pin, *a*, of the vibrator mechanism should then be set into the hole in the front head and held in place temporarily by a small set collar while the secondary winding is put on. This winding consists of 1 1/2 pounds of No. 33 double-

silk-covered wire. The starting end should be soldered to a piece of No. 16 copper wire and the latter threaded through the back head and attached to one of the secondary binding posts, which must be screwed into the back head, preferably into the face of the block rather than the edge.

Before proceeding with the winding of the secondary coil both of the heads should be faced with hard rubber about 1/32 in. thick. The last layer should end next to the back head and the final end of the wire be threaded through a small hole in the head and carried to the other binding post. The binding posts are not shown; ordinary telegraph instrument posts should be used, such as the binding posts used on standard sounders. In winding on the secondary wire, tension should be applied to it by means of rollers in order to avoid damaging the insulation by friction; six or eight grooved rollers should be mounted on spindles and the wire threaded through them backward and forward so as to obtain a braking effect with the least possible amount of friction on the wire.

The vibrator consists of a piece of flat spring steel 1⅞ in. long, ¾ in. wide and No. 28 gauge in thickness, with a disc of soft steel ¾ in. in diameter sweated to its free end; the disc and the end of the spring must, of course, be thoroughly tinned before attempting to sweat them together. The spring is attached to the mount, *b*, by means of two No. 8 brass machine screws and nuts, insulated from the mount by a flat piece of hard fibre, *c*, 3/16 in. thick, ½ in. wide and 1 in. long, and two fibre bushings

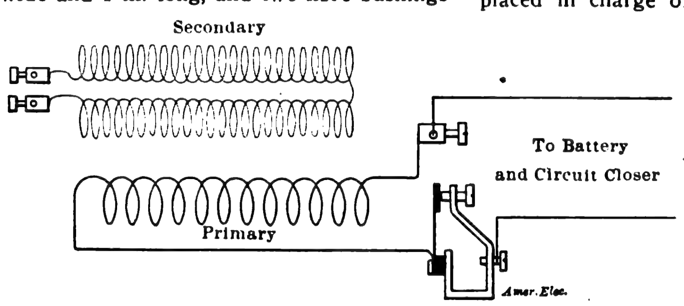


FIG. 3.—DIAGRAM OF CONNECTIONS.

set into the holes in the mount and having heads ⅛ in. thick. (See Fig. 2.) The mount, *b*, is made of strip brass ⅛ in. thick, 1 in. wide and 3⅝ in. long. The construction and arrangement are so simple and obvious that further explanation is scarcely necessary. The contact screw is an ordinary telegraph relay screw with a platinum point; it can be bought from any maker of telegraph instruments for a few cents. A round milled nut should be fitted to the thread on the outer end of the supporting pin, *a*, so that it turns somewhat stiffly; otherwise a jam nut will be necessary. The spring surrounding that part of the supporting pin between the front head and the mount may be made of No. 18 spring brass and it should be wound on a mandrel the same size as the pin, so that it will be slightly larger in the bore when released just after being wound.

The complete coil should be boxed in by means of hard wood strips ½ in. thick screwed to the edges of the heads; the bottom strip must project beyond the front head far enough to serve as a seat for the horizontal part of the vibrator mount, as indicated by the dotted lines in Fig. 1. After the bottom and the two side strips have been screwed on, the box thus formed should be filled with melted paraffine wax; then the top strip may be screwed in place and the coil is finished. Fig. 3 is a diagram of connections.

ISOLATED PLANT ENGINEERING.

BY JAMES F. HOBART.

The lot of the engineer in charge of a small or medium sized isolated steam plant is frequently far from a happy one. Frequently he is handicapped by having an "owner" who "knows it all" and who dictates to him without sense or reason. The oil, waste, fuel, tools and appliances are often purchased without his opinion being asked as to what is desirable or even necessary. Sometimes, however, it is the engineer who is to blame, and not the "owner." There are many engineers who will use no exertion to better themselves or their surroundings; insomuch so that it is useless to tell them how to improve things or how to make the best of their condition.

The writer knows of one man in charge of a small steam plant who for two years shoveled coal from a dirt floor in front of the boiler rather than put down a brick pavement; all the material being on hand and available. On the other hand may be noted the example of a man who was placed in charge of a homely old engine covered with rust and dirt and located in a shed. In less than two years this engineer had transformed the old shed into a brick-walled structure with a concrete floor; the engine had been nicely painted, and the interior of the building would not suffer by contrast with more pretentious engine rooms.

Next to having no voice in the selection or purchase of supplies, is the irritation of having an incompetent fireman who is hired by the "owner" and over whose dismissal the engineer has no control. When a man is sent to fire who will open the furnace doors and begin to break up a soft coal fire with a slicebar without first looking to see where the water level stands, he needs watching, for he is a dangerous man to have around.

Sometimes the same man, or one like him, will shut off the feed to a boiler without stopping the pump or opening some other passage for the water. Another trick is to leave a bed of coal, ashes or clinkers anchored against the bridge wall while there is a pile of blazing coal in front of the furnace close to the doors. This kind of work is not always limited to the fireman; it can be recognized in the engineer who cleans the brass work of an engine only where it happens to be in front. Valves made bright on top only, do not look well when the hand-wheel is turned half way over and dirty surfaces brought to light. When a man is packing rods or stems, note whether he takes out the old packing and puts in new, or whether he forces in another ring or two on top of the old packing, and then pretends to have done a good job. The first method never cuts rods—the second should never be imitated.

There are some "dont's" for the engineer as well as for the fireman: If there is a slight knock or pound in the engine which you intend to take up, don't delay doing it until just before the engine is started in the morning. When the engine is warm, say after shutting down at noon or at night, is the proper time to make such adjustments, for then the several pieces are expanded and the adjustment can be made as close as is necessary without having to make guess allowances for expansion. Many an engineer has come to grief by setting up connections when the engine was cold.

Another point for the isolated station man is in the care of belts and pulleys. Never let dust accumulate in pulleys. Have them cleaned at least monthly. A belt, be it made of rubber, leather or cotton, requires as much care as a journal bearing or the inside of an engine cylinder. A belt left to itself will never do the work intended by the engineer. Every inch in width of a good double belt is expected to exert a continual pull of 88 pounds when at work; but if it is not kept at the proper tension it will be folly to look for the expected results. To obtain 88 pounds effective pull the length and slack of the belt, together with its adhesion to the pulley, must be such that at least 44 pounds pull per inch of width will exist in the slack or return fold of the belt.

When a belt is stretched between two horizontally placed pulleys, the distance apart of the pulleys, the length and weight of the belt per foot, determine the tension of the belt and the pull it will exert when running. If a belt sags just right to bring the proper pull of 88 pounds on the working side or fold when the belt is running, and is clean and soft enough to obtain the proper hug or "bite" upon the pulleys, then it will easily transmit the amount of power it was figured for. If, on the other hand, the belt is allowed to become hard, dust filled and too slack, then there will be slipping between the belt and one or both the pulleys, the necessary power will not be transmitted and the life of the belt will be short and unsatisfactory.

Another bad error which is frequently made in the design of isolated plants, is the use of pulleys far too small for the work expected of them. Compare the work done, and the cost of pulleys and belts necessary to transmit 100 horse-power between shafts 16 in. apart with pulleys 48 in. by 16 in. in one case, and 63 in. by 12 in. in the other. Both sizes of pulleys are designed to transmit 100 horse-power, and the list price of the 48-in. by 16-in. pulley is $60.20 each, and the 63 in. by 12 in. set is $73.30 each, or $120.40 and $146.60, respectively. The length of belt in either case will be 44.6

ft. and 48.5 ft., respectively. Assuming the 16-in. belt to cost $4 per foot and the 12-in. belt $3, the cost of the belts will be $178.40 and $145.50, making a total cost for each installation of $238.60 and $278.80. Thus, the large pulleys and narrow belt cost $40.20 more than the small pulleys and wider belt, but when it comes to renewals it is another story, for it will cost $32.90 more to renew the 16-in. than it does the 12-in. belt, hence the large pulleys and narrow belt should be specified for economy.

One thing in particular, which it pays well to look after, is the influence of weather conditions upon belts. Leather in its natural state is very susceptible to moisture and to climatic conditions. Rubber and "Gandy" (impregnated stitched cotton) belts are also affected by dry or wet atmospheric conditions, but it acts in different ways with the materials named. When a leather belt is exposed to damp air, the first result is it shortens in some instances sufficient to cause hot bearings in shaft or machine. If the moisture is long continued or increased to an extent that the belt becomes wet instead of damp, an amount of stretching will be observed for the reason that a leather belt, when wet, is more easily stretched than when dry. Hence the apparent paradoxical effect of moisture upon leather belts whereby they first shorten on exposure to moisture and then stretch, sometimes to an alarming extent. The remedy is to fill the leather with certain oils or other substances which will render the leather proof against any humidity changes likely to be met with. The natural waterproofing for leather is neatsfoot oil, but almost any oil which will not evaporate will do. An engineer of the writer's acquaintance uses cylinder oil on the governor belt of his engine, and has never had the belt go slack or tight, no matter how the humidity conditions might vary. In many machine shops, the lathe belts are soaked with black lubricating oil and they do business right along to a capacity far above 88 pounds for inch of width (66 pounds for single belts) and are never too slack or too tight. There are several excellent belt dressings in the market which will protect leather belts from humidity if properly and plentifully applied.

Rubber belts are supposed by some to be impervious to water, but this is a mistake. When a rubber belt is new, it is practically impervious to water, but as soon as the belt begins to run over pulleys, the rubber covering alternately stretches and compresses, and soon opens to a certain extent and air is drawn into one side of the belt. As a certain percentage of moisture goes into the belt with the air it is certain to come in contact with the cotton body of the belt. Almost any oily substance, which will keep out moisture, seems to soften the rubber covering and thus injure the belt. There is, however, one substance which works very well on rubber belts as well as leather and cotton ones. This substance will be referred to later.

Belts made of cotton duck afford about the best and cheapest method of transmitting power known to the engineer outside of electricity. But cotton is very susceptible to humidity and cannot be used without ample protection from the least variation of humidity in the atmosphere. Otherwise, cotton duck, folded and stitched, or woven to the required thickness would make the ideal belt for any service or condition.

The usual cotton belt is filled with either linseed oil or a substitute or else with a mineral oil or paraffin substance. The writer prefers the latter. The linseed oil stuffing oxidizes and becomes hard, whereas the paraffin filling does not oxidize and causes the belt to remain soft and pliable for a long time. If measures are taken to replace the wear of the belt filling as fast as it disappears, there is no other belt which for efficiency and cost can approach the stitched cotton belt. As stated, there is a certain substance which protects not only cotton belts but leather and old rubber belts. The writer refers to the substance known as "cling surface."

The height of perfection is reached when cotton belts are procured "in the white" before they have been impregnated. Then, the substance named will penetrate quickly and thoroughly and a belt will be obtained which leaves nothing to be desired. It is far better than either leather or rubber, for any purpose to which belting can be applied and it is equally good for rope transmissions of power. The writer has personal knowledge of the performance of belts impregnated in this manner which leads him to consider that for all isolated station work, engine belts included, nothing better has yet been brought to trial than the plain stitched cotton belt filled with the substance named.

The writer has been surprised by the almost universal practice of owners and some engineers in the matter of boiler feeding. Thirty plants of which he has knowledge are supplied with a belted boiler feedpump, either driven from the engine shaft or from the main shaft, but in almost every one of the plants in question, the power pump has been permitted to remain inactive. Each of the plants is also provided with a duplex steam pump, and in some instances an injector, making three methods of feeding the boiler; but the steam pump or the injector are almost invariably used at considerable greater expense to the owner, notwithstanding the fact that the power pump was furnished with a bypass by means of which and a single valve the pump could run all the time and a constant and uniform stream of water sent into the boiler to replace evaporation. In spite of the convenience noted, the cheap and efficient power pump remained inactive and the boilers were fed with the expensive steam pump and an occasional injector.

There are several ways of cleaning fires depending upon the kind of fuel burned; but assuming that anthracite slack is used with enough bituminous mixed to make it burn well, it is the writer's practice when plain grates are in use to put in a good firing of fresh coal and let it get up to a good clear red. The damper is then closed and the live coal raked over on one side of the grate, then the ash and clinker are raked from the other half of the grate. This being done, the burning coal is moved to the cleaned side of the grate, and the remaining ashes hoed out, the live coal is then spread evenly over the whole grate and the damper opened. As soon as the coal becomes bright red the boiler should be fired rapidly again, and as soon as it is well brightened up it should be fired to the usual depth.

A man can clean a fire in a single boiler in this way and not have the pressure drop more than 8 or 10 pounds during the operation. If particular attention be taken to close the damper the drop in steam pressure will be much less than if the damper be left open. It is the cold air blowing directly against the boiler shell which lowers the steam pressure. With the damper closed the heat contained in the setting and in the red hot fuel will go far to keep the pressure up until the fire has been fully cleaned. It is not to be understood that the damper is to be shut so tight that all the hot gases puff out into the face of the man who is doing the cleaning. If the damper is very tight fitting it should be left open a trifle. When several boilers are operated in battery it is an easy matter to cut out one boiler by closing the damper, then as much time may be taken as is necessary for cleaning, since the other boilers will keep the pressure up. When a single boiler has to have its fire cleaned, quick work must be done.

Another method of cleaning a fire is as follows: The fireman fires one side, letting the other side get low. As soon as the fired side is burning freely the low side is cleaned and some fresh coal thrown upon the grates, then the live coal is pulled over upon the green coal and allowed to come to a bright red. The remaining side of the grate is then cleaned as soon as it has burned down, some green coal is spread there, and the fire again distributed evenly over the grate, after which it is fired lightly and allowed to come to its normal condition for a run of several hours to the next cleaning time.

The chief objections to the latter method of cleaning a fire, are the number of operations which have to be performed and the great length of time the fire is partially out of complete maximum service. It will require a half hour to clean a fire by the second method, while seven to ten minutes will suffice for cleaning by the first method.

International Association of Municipal Electricians—At the tenth annual convention of this body at Erie, Pa., August 23, 24 and 25, the following officers were elected: President, Jerry Murphy, Cleveland, Ohio; vice-presidents, William Crane, Erie, Pa.; H. R. Allensworth, Columbus, Ohio; B. A. Blakey, Montgomery, Ala.; F. A. Cambridge, Winnipeg, Man.; secretary, F. P. Foster, Corning, N. Y.; treasurer, C. E. Deihl, Harrisburg, Pa. Executive Committee: T. C. O'Hearn, Cambridge, Mass., chairman; A. S. Hatch, Detroit, Mich.; J. B. Yeakle, Baltimore, Md.; Louis Gascoigne, Detroit, Mich.; W. M. Petty, Rutherford, N. J.; James Grant, New Haven, Conn.; W. H. Thompson, Richmond, Va.; W. Y. Ellet, Elmira, N. Y. Finance Committee: D. D. Clayborne, J. F. Macdonald and H. C. Bundy.

HIGH TENSION CIRCUIT BREAKING DEVICES.

BY W. T. FERNANDEZ.

With the development of high-tension transmission systems, the necessity for an automatic device to break a high-tension circuit under short-circuit conditions set engineers at work on the perfection of such a device. Various air-break, sand-break and fuse-break devices were tested with unsatisfactory results, until it became evident that a radical departure from existing methods was necessary to attain the desired results; hence the oil-break switch.

As several types of oil-break switches are in general use, the mechanical and electrical features of each will be considered in its turn. The compressed air type will be eliminated as obsolete and the first form of the General Electric type "H" oil switch will be described.

This switch consists of an ingenious combination of motor and spring drive. The truss, carrying the circuit-closing spindles, is actuated by a crank connected to the motor drive by a worm gear, which in turn is actuated by the magnetic thrust clutch illustrated in Fig. 1. When the operating current is applied, the clutch, *C*, is thrown into contact with the clutch, *CC*, by the thrust rod, *R*, which is driven forward by the solenoid.

The motor is series wound and is connected in series with the solenoid, so that the clutch is interlocked the instant the motor starts, carrying the crank attached to the gear wheel, *G*, over its center, thus releasing the top spring which bears on the truss, forcing the latter downward. The crank shaft is connected to the gear wheel through a friction clutch which, while it permits the shaft to travel faster than the gear wheel in one direction, will not allow it to be turned backward, so that the action of the switch is progressive and always in one direction. The closing motion is performed by a one-half turn of the crank shaft and the succeeding opening motion by a second half turn of the crank shaft.

The travel of the switch is determined by a limiting device consisting of three movable contacts, usually called fingers, actuated by three cams mounted on the crank shaft and so set that the master finger (1) will make contact with a small bus-bar an instant before the closing finger (3) is released; thus continuing the circuit until its actuating cam releases it. At the same instant finger 2 is thrown into contact with the bus-bar, thus furnishing a path for the current for the opening motion. (See Fig. 3.)

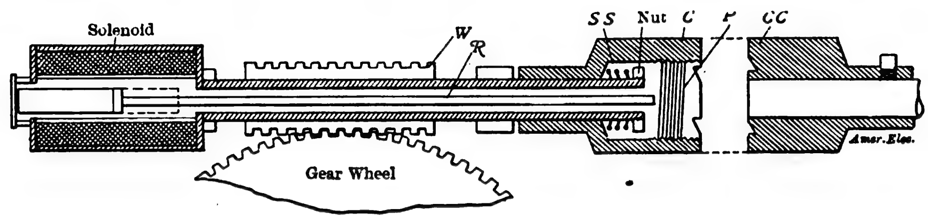


FIG. 1.

It will be evident from the action of the cams and fingers, that the limiting feature is finger No. 1 and that the switch's travel is determined by the adjustment of the cam (Fig. 6) actuating that finger, as the mechanism is disconnected from the motor by the release of the clutch, *C*, the instant the operating circuit is opened by the master finger. If that finger remains on the bus-bar too long, the crank will be carried past the bottom center and the mechanism thrown upward by the bottom spring to the open position. With the Niagara type of control switch (Fig. 3) operating current will be applied as soon as finger 3 is closed on the bus-bar, thus throwing the switch in again. The rapid opening and closing of a switch (commonly called "pumping") is dangerous to both switch and apparatus, and, therefore, the adjustment of the master finger should be carefully noted. A center mark is indicated on the gear case and a pointer on the crank shaft indicates how close the crank is to center in both the open and closed positions. That pointer should always be set at least 1-16 of an inch back of center (the term back of center is used as indicating the direction reverse to the pointer's travel).

It will be seen in Fig. 1 that the half of the clutch, *C*, mounted on the end of the worm shaft is movable, so that it may be thrust forward by the rod, *R*, under the influence of the solenoid, which drives it against the screw plate, *P*, in front of the clutch jaw. When the operating circuit is opened by the master finger, the clutch jaw and thrust rod are drawn away from the motor clutch jaw by the spring, *SS*, thus stopping the mechanism and allowing the motor to slow down gradually.

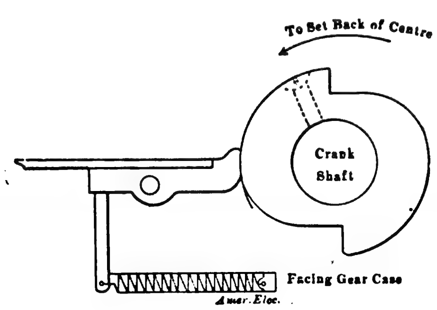


FIG. 2.

It sometimes happens that the screw plate, *P*, works loose, lessening the travel of the movable clutch jaw to such an extent that it will not properly interlock with its fellow on the motor shaft, with the result that the jaws will be stripped from one or both halves of the clutch. A minimum clearance of 1-16 of an inch should be allowed between jaws and when regular inspection—which should be made once every twenty-four hours—reveals by the use of a gauge, a lessening of that clearance, the motor should be taken down and the screw plate examined. Another cause of trouble on this type of switch is that the oil used to lubricate the worm shaft and gear wheel, works down into the dogs of the friction clutch, causing them to slip and allowing the mechanism to fall back from the open position. A mixture of good grease and graphite applied sparingly once a month will keep the parts in good condition and prevent the dogs slipping. The newer type "H" differs slightly in mechanical details from the type described, and is equipped with a clutch which is entirely magnetic. (Fig. 4.)

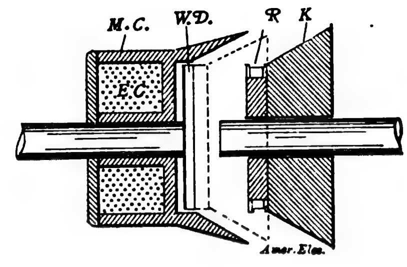


FIG. 4.

The end of the worm shaft, *W*, is turned into a disk, *WD*, housed in the casting, *MC*, which carries an energizing coil, *EC*, connected in series with the switch motor. On the motor end is mounted a movable armature, *K*, keyed so as to move back and forth freely on the shaft. This armature is fitted on the inner side with a wooden ring, *R*, fastened to it by a binding similar to that used for binding the coils of an armature, and projecting about 1-64th of an inch beyond the core. This ring forms the friction element of the clutch.

When operating current is applied, the coil, *EC*, is energized as the motor starts, and draws the armature, *K*, into contact with the disk, *WD*, thus transmitting the motion of the motor to the worm shaft and mechanism of the switch. The release of this type of friction clutch is determined by the master finger as in the mechanical clutch type, but has a few faults peculiar to itself.

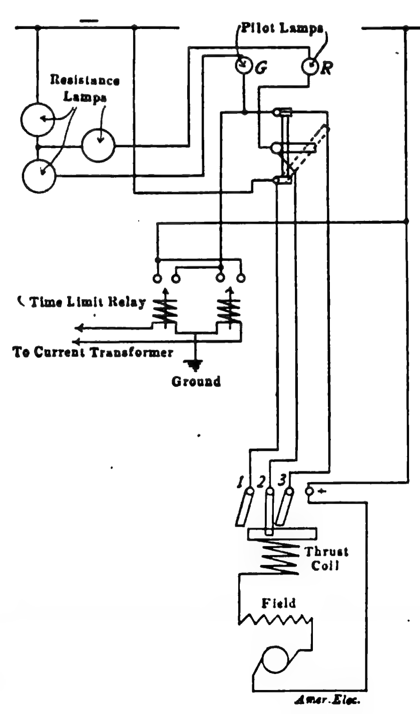


FIG. 3.

The binding band of the wooden friction ring will sometimes work loose and permitting that ring to turn, will throw the switch over the center, when it will be thrust downward by the top spring, but will not

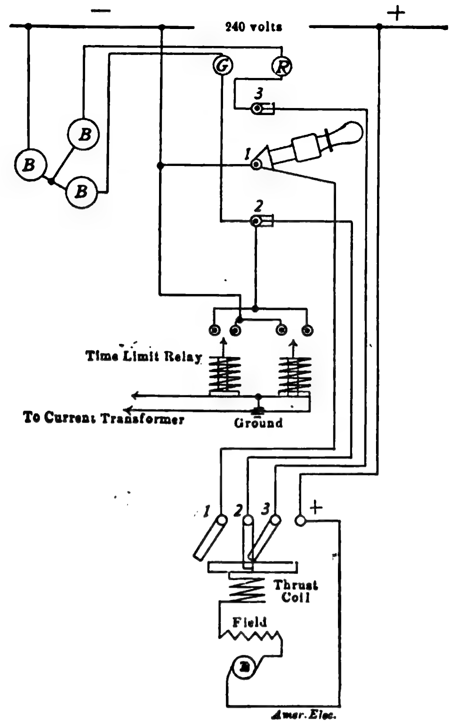


FIG. 3-A.

bind with sufficient force against the disk, *WD*, to carry the switch home. The only remedy is to rebind the wooden ring, and the binding must be applied with force. It will be found that after such a condition has arisen that the face of the friction ring has been worn smooth and will not hold firmly at once, if the face of the ring is roughed up a trifle with coarse sandpaper, the clutch will take hold and do its work, after being rebound. Care should be used when oiling the mechanical parts of this type of switch that no oil reaches the clutch

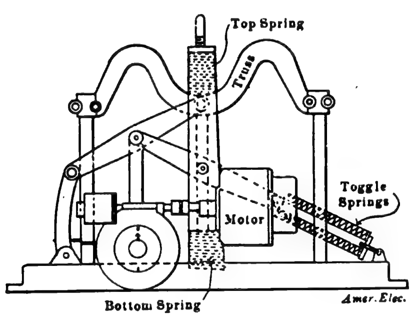


FIG. 5.

faces, as oil will render the clutch inoperative, and necessitate the thorough cleaning of those parts and the roughing of the wooden ring with sandpaper to restore the necessary friction between the two faces of the clutch.

Another source of trouble on the two types mentioned is an unbalance in the top and bottom thrust springs, which sometimes exists on account of the impossibility of tempering any two springs exactly alike. The master finger may be set to cut off at the proper point on the opening motion but will carry over the bottom center. As a rule, the master finger may be set far enough back of the top center to give a safe margin on the bottom center, but in exceptional cases it will be found necessary to take up on the toggle springs (Fig. 5) whose function is to render the opening motion more rapid than the closing motion—to compensate for the unbalance of the thrust springs. In some rare cases even this expedient is not sufficient and the switch will still carry over the bottom center; the only remedy then is to split the cam which actuates the master finger so that two independent cut-offs are obtained. With the single cam, the top cut-off bears a certain definite relation to the bottom cut-off, but if the master finger cam is split, each point of cut-off may be set independent of the other and any unbalance of either the top or bottom spring thus adjusted. Pumping may also be caused by a variation of the e.m.f. of the control current, and in unavoidable cases the switch should be set at the maximum voltage carried.

The oil pot contact is illustrated in Fig. 6. The bottom contact is set into a space provided for it in the bottom of the oil pot and is held therein by a screw ring. The four sections of the contact are held together by two spiral springs, formed into a circle and sprung around the outside of the contact blocks. If one of these springs breaks, a loose connection between the spindle and bottom contact results, causing heating of the oil in the pot. Cleaners should, therefore, be instructed to feel each pot and report any unusual temperature. Where doubt exists as to the heating of a certain connection, place a small lump of paraffine on the end of a stick of seasoned wood and touch the part while it is carrying load; a softening of the paraffine indicates the faulty

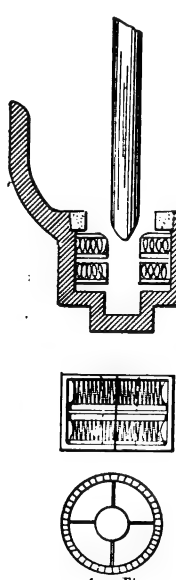


FIG. 6.

connection. The wiring diagram shown in Fig. 3A, illustrates the most approved method of control for type "H" switches. The control switch is always open, so that if the oil switch "pumps" it can only return to its original position and cannot continue to open and close as in the Niagara type, since when the operating finger of either the opening or closing motion comes into contact with the bus-bar on the switch, it is always "dead" after the initial operation has been performed.

The direct-current circuit of the time limit or overload relay is slightly different from that used with the Niagara control switch. Instead of energizing a tripping magnet, the tripping circuit of the relay is closed directly through the oil switch wiring and throws open the switch without any secondary device. The simplicity, as well as the safety, of this method of control will be understood by a study of the wiring diagram Fig. 3A. It will be noticed that the pilot lamps shown in Figs. 3 and 3A indicate by becoming luminous whether the oil switch is open or closed.

The object of connecting other lamps in series with the pilot lamps is to prevent the possible opening of the switch by short-circuiting the filament of the pilot lamp. It is impossible by short-circuiting any one of the lamps to open the switch, and the method is safer than the introduction of wire resistance in the pilot circuit since the short-circuiting of that resistance would blow the pilot lamp and open the oil switch.

PRACTICAL NOTES ON BOILER FEEDING APPARATUS.

BY CHARLES L. HUBBARD.

Feed-Water Heaters.

Feed-water heaters are employed for two important reasons: First, if cold water is introduced into a boiler in any considerable quantity the cooling effect will cause an unequal contraction of the plates, which is likely to produce leaks at the joints. It also tends to reduce the steam pressure and necessitates more rapid firing for a time after feeding, unless the load upon the engines is practically constant, so that the feed valve can be set to supply a uniform quantity of water continuously.

Second, feed-water heaters can nearly always be arranged to utilize exhaust steam or waste gases from the furnace, so that a substantial saving in fuel is gained by their use.

The percentage of saving in fuel by heating the feed water with waste products is expressed by the equation

$$\frac{100\ (I_2 - I_1)}{L + (I_3 - I_1)},$$

in which

I_1 = initial temperature of the feed water entering the heater.

I_2 = final temperature of the feed water leaving the heater.

I_3 = temperature of the steam at boiler pressure.

L = latent heat of evaporation for steam at boiler pressure.

Example.—What will be the saving in fuel by using an exhaust steam feed-water heater when the initial temperature of feed water is 60°, the attainable final temperature 205°, and the steam pressure in the boilers 80 pounds, gauge? From a steam table the temperature of steam at this pressure is found to be 324° and the latent heat of evaporation 886°. Substituting these values in the formula:

$$\frac{100\ (205 - 60)}{886 + (324 - 60)} = \frac{14{,}500}{1{,}150} = 12.6\%$$

This is true because the total heat required per pound of steam is that necessary to raise the temperature of the feed water from 60° to 324°, which is 324 — 60 = 264 heat units, plus that required to evaporate it into steam at this temperature, which is 886 heat units, making a total of 264 + 886 = 1,150 heat units. The saving made by heating the feed water from 60° to 205° is 205 — 60 = 145 heat units. Therefore, the gain in per cent is $\frac{145 \times 100}{1,150} = 12.6$.

With the most economical multiple expansion engines only about 18 per cent of the heat stored in the steam leaving the boilers is transformed into work, and in the majority of engines probably not more than 10 per cent is utilized. If we assume 15 per cent as an average, this leaves 85 per cent of the heat in the total amount generated, available for heating purposes, and of this amount only a comparatively small proportion can be used for feed-water heating under ordinary conditions. In office buildings, factories or other buildings having their own power plant, this remaining portion is usually employed for warming and ventilating purposes.

The proportion of heat in the exhaust steam which can be used for feed-water heating may be easily determined as follows: The latent heat of evaporation for steam at atmospheric pressure is 966 heat units: that is, each pound of steam gives out 966 heat units when it is condensed. The quantity of heat required for raising the temperature of one pound of water from 50° to 210°, which may be taken as maximum requirements, is 210 — 50 = 160 heat units. Therefore, only $\frac{160}{966}$, or approximately 1/6 of the heat in each pound of exhaust steam can be utilized in warming the pound of feed water which is to replace it in the boiler. Heaters using exhaust or live steam are divided into two kinds, known as open and closed heaters. When the waste gases from the furnace are employed the apparatus is commonly called an economizer. Open heaters usually consist of a chamber of cast iron or steel plate, into which the steam is admitted. Cold water is fed in at the top and in most forms is made to fall in thin sheets by flowing over shallow trays placed one below the other. The intimate contact of the water with the steam heats it to a temperature very nearly that of the steam. When the water contains scale-forming salts, which are precipitated at temperatures below that to which the water is heated, the sediment is caught by the trays and can be removed from time to time as required. Heaters of this form are sometimes provided with filters which still further purify the water before it is pumped to the boilers.

As the condensed steam is mixed with the feed water, it becomes necessary to pass it through an efficient oil separator before it enters the heater.

Fig. 1 shows a section through a Cochrane feed-water heater and purifier, which is of the type just described.

The cold water enters at the top and trickles downward over intercepting trays to the receiver at the bottom. When the water line in the receiver reaches a given

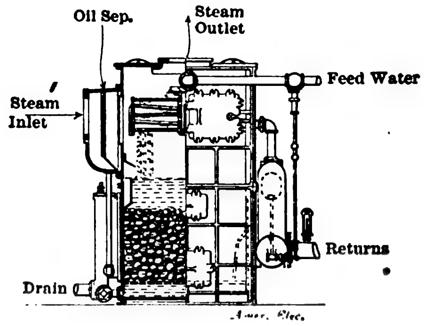


FIG. 1.—OPEN FEED-WATER HEATER.

point, a valve operated by a float closes the supply. Exhaust steam enters at the side through an oil separator and passes out at the top of the heater. The oil from the separator is trapped to the sewer.

When used in connection with a heating system the returns are brought back as shown. All drips from separators, steam jackets, etc., may be trapped into the receiver.

Before being pumped into the boilers

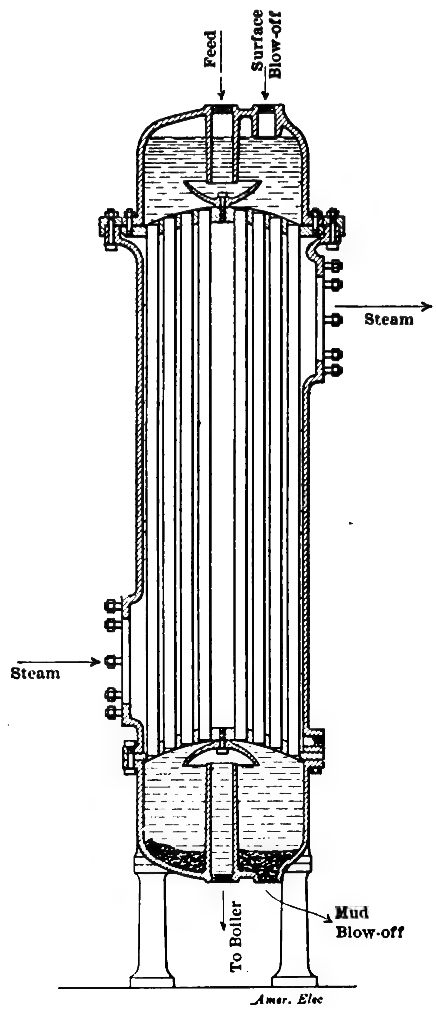


FIG. 2.—CLOSED FEED-WATER HEATER.

the water passes through a coke filter at the bottom of the receiving chamber.

With a closed heater the feed water does not mingle with the steam, but passes through a series of brass or copper tubes which are surrounded with steam on the outside. The Goubert heater shown in Fig. 2 is a good illustration of this type. Closed heaters are made for use in both vertical and horizontal positions, the former, however, on account of the small floor space required is usually preferable, unless it is desired to suspend it overhead. There are various forms of construction employed, some having straight tubes while in others the heating surface is in the form of a coil. When straight tubes are used one end is made to slide in a stuffing box or ground joint in the tube sheet in order to provide for the unequal expansion of the iron shell and the brass or copper tubes.

The required amount of heating surface depends upon the initial temperature of the feed water, the steam pressure within the heater and the velocity with which the water flows through the tubes. With exhaust steam from non-condensing engines it is customary to allow about one square foot of heating surface for each 90 pounds of water passed through the heater per hour. When the exhaust from condensing engines is used the surface should be increased about 50 per cent, owing to the lower temperature of the steam. This is equivalent to about 1/3 of a square foot of heating surface per boiler horse-power when non-condensing engines are used and 1/2 of a square foot for condensing engines.

The temperature to which the feed water may be raised usually varies from 200° to 210° with exhaust steam from non-condensing engines, and from 110° to 120° in the case of condensing engines. In many condensing plants the exhaust from the various pumps and other auxiliaries is sufficient to heat the feed water for the entire plant.

When the exhaust from these sources is equal to about 1/6 of the entire quantity of steam generated by the boilers, there will be nothing gained by placing a heater in the exhaust pipe leading to the condenser; but if the exhaust from the auxiliaries is less than this amount, then the feed water may be first passed through a heater supplied with steam at condenser pressure, and then through a second heater taking the pump exhaust at atmospheric pressure, which will heat the water up to a temperature of about 205°.

A HIGHLY EFFICIENT AND EASILY MADE WATER RHEOSTAT.

BY H. Y. HADEN.

Many engineers know the little troubles connected with rigging up a temporary water rheostat for taking up the load while testing engines. Barrels and plates are usually employed, and a very usual weakness lies in the boiling of the water, and the consequent rapid fluctuation of the load, which always depreciates the engine performance. It is also generally necessary to use salt in the water, and too much of this will put the rheostat out of control. In Fig. 1 is given a diagram of a rheostat in which galvanized iron wire, immersed in pure water, is used. The one in question ab-

sorbed a load of 100 kilowatts for nine hours continuously, with less than 1 per cent fluctuation, the final adjustment being obtained by controlling the inflow of circulating cold water, which simply overflowed the trough.

There were four coils used, which were all connected at one end to a copper rod. The other ends were each operated by switches, so that approximately 1/4, 1/2, 3/4 and full load could be obtained at will. Two of the coils were of No. 14 B. & S. gauge, 180 ft. long, and were made by winding on a 1 1/4-in. arbor. The remaining two were made of No. 16 B. & S. gauge and were 150 ft. long.

The receptacle in this case was a common horse drinking trough, and the coils

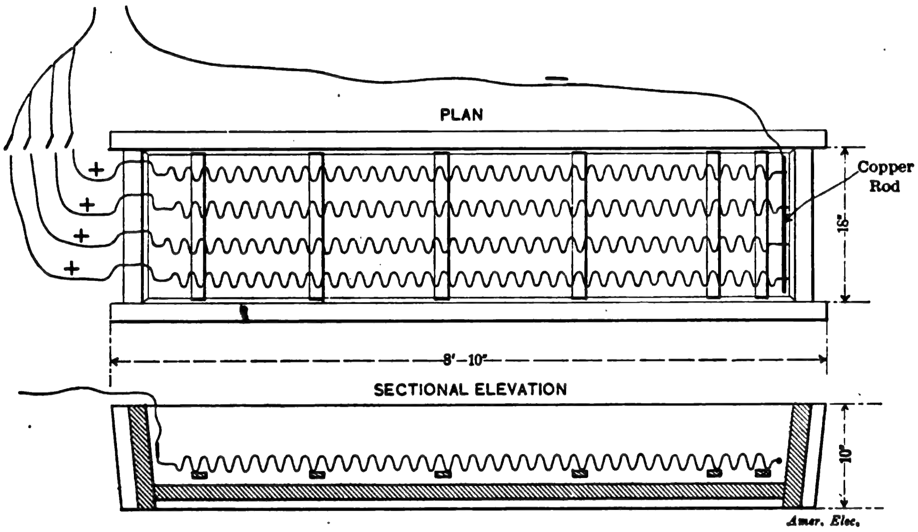


FIG. 1.—WATER RHEOSTAT.

were laid on a number of supporting cross-pieces. As there was a 3-in. clearance between each coil there was no tendency to touch. Accompanying this is a table giving the data concerning the carrying capacity of iron wire under water.

CARRYING CAPACITY OF GALVANIZED IRON WEAR IN WATER.

B. & S. Gague.	Amperes.	Feet per 110 volts.	Feet per 550 volts.	Feet per pound.
20	36	25		369
19	42	27		293
18	50	29		232
17	60	30		164
16	71	32		146
15	88	34		107
14	103	36		91.9
13	122	38		72.1
12	145	40	200	57.8
11	173	42	210	45.8
10	205	45	225	36.4
9	245	47	235	33.3
8	293	58	290	25.0

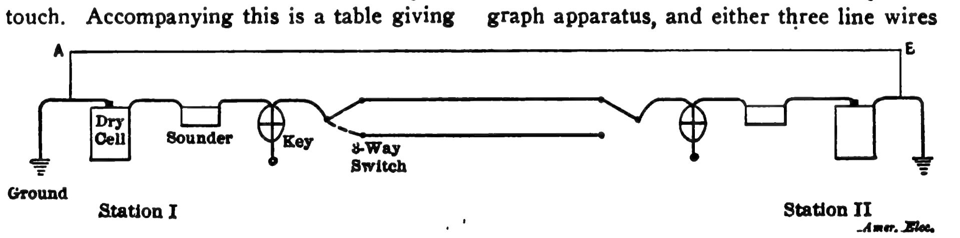
American Street and Interurban Railway Association.—At the 24th meeting of the American Street Railway Association, now known as above, held in Philadelphia, September 27 and 28. W. Caryl Ely was re-elected president.

Letters on Practical Subjects

Communications intended for publication in this department must be received at this office not later than the 15th of the month prior to the date of publication.

Telegraphing with Open Circuit Batteries.

I enclose herewith a sketch for a new arrangement of private or amateur telegraph outfit which might prove attractive to your readers, as it eliminates the obnoxious "crowfoot" cell. Little explanation is needed, as the diagram is almost self-explanatory. Two three-pole switches are connected as shown to the ordinary telegraph apparatus, and either three line wires



TELEGRAPHING WITH OPEN CIRCUIT BATTERIES.

or two line wires and a good ground return may be used. The operation of the key switch is the same in all cases. The three-way switches are shown in a position ready to operate. The dotted line of the switch at Station I shows the circuit open and not in use, while the line A B shows the third line wire or complete metallic circuit.

R. C. JACKSON.

Los Angeles, Cal.

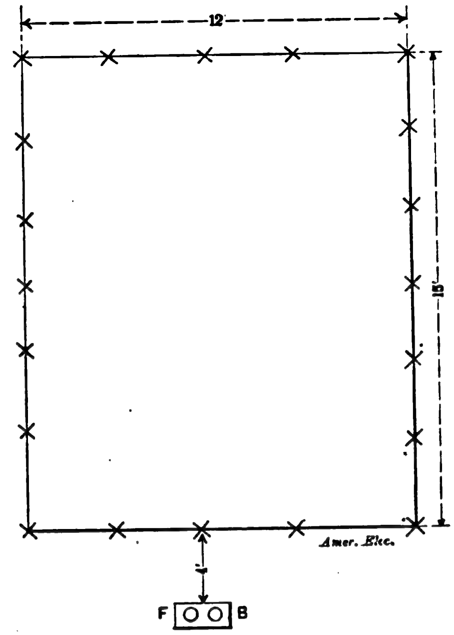
Information Wanted.

Can any of the readers of the AMERICAN ELECTRICIAN inform me how I can ring a 800-lb. fire bell continuously, or signal at a distance of 1000 feet from same without installing an expensive ringer? I have a 3/4-h.p. motor, and the current supply is 110 volts alternating current.

Gonzales, Tex. C. I. BOQUET.

Problem in Lamp Installation.

The sketch herewith shows a room 12 ft. by 15 ft. It is desired to wire this room for 20 incandescent lamps, as indicated. The



PROBLEM IN LAMP INSTALLATION.

lamps are to be placed on the walls near the ceiling, and the fuses are to be placed four feet below the line of the lamps. The available voltage is 220, but the lamps to be used are 110-volt, 4-c.p., screwed into ordinary open-wire Edison receptacles. The problem is to do the wiring with the least amount of material.

FRED MAHAFFEY.

Paris, Texas.

Alternating-Current Power Measurement.

Accompanying is a diagram of connections for three-phase power measurement as asked for by Mr. Lisberger in the August number. The scheme requires three wattmeters, together with current transformers and potential transformers. The potential transformers have a ratio of 10:1; that is, with a primary voltage of 2300 a secondary voltage of 230 is obtained. In the diagram the meters are connected up as three separate single-phase meters. A, B and C are the current transformers, the secondaries of which, SS, connect with the current coils of the meters; a, b and c are the potential transformers, the secondaries of which, SS, are connected to the pressure coils of the meters. If the dial constant of the meters be represented by K the constant for each meter will be 1,600 K, which is obtained by multiplying the ratio of the current transformer by the ratio of the potential transformer. The total output is the sum of the three meter readings times this constant. No change can easily be made if the meter constant is an awkward number, for to make the constant an even number, the gearing of the meter will have to be altered.

H. F. MUNSON.

Oakland, Cal.

In answer to Mr. Lisberger's inquiry regarding the measurement of three-phase power, I would suggest the arrangement shown by Fig. 2. An artificial neutral is produced, which without stepping down

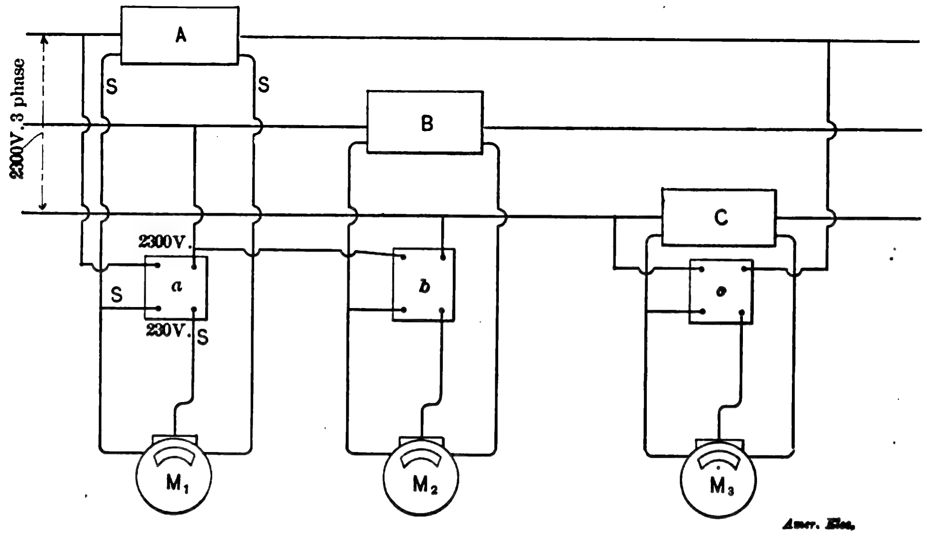


FIG. 1.—MR. MUNSON'S SOLUTION.

would give 1908 volts on the potential coils of the meter. As the meters are wound for

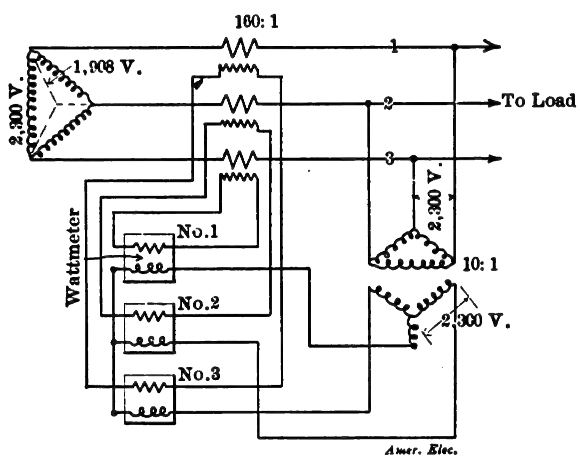


FIG. 2.—MR. UMSTEAD'S SOLUTION.

220 volts, it is necessary to step the voltage down as shown. The constant would then be $160 \times (10 \div \sqrt{3})$. A new scale could be figured out and pasted over the old scale in such a manner as to be easily removed when necessary.

Wilkinsburg, Pa. E. J. UMSTEAD.

To solve Mr. Lisberger's problem in alternating-current power measurement, only two wattmeters are required. These are connected as shown by Fig. 3. By the use of the series transformers the power is reduced to $\frac{1}{160}$th while the shunt transformer reduces the power to $\frac{1}{20}$th. Thus the power measured is $\frac{1}{160} \times \frac{1}{20} = \frac{1}{3200}$, the power actually taken by the receiver circuit. The constant is therefore 3,200, and the total power is equal to 3,200 times the sum of the wattmeter readings.

Elkhart, Ind. A. H. SWEETNAM.

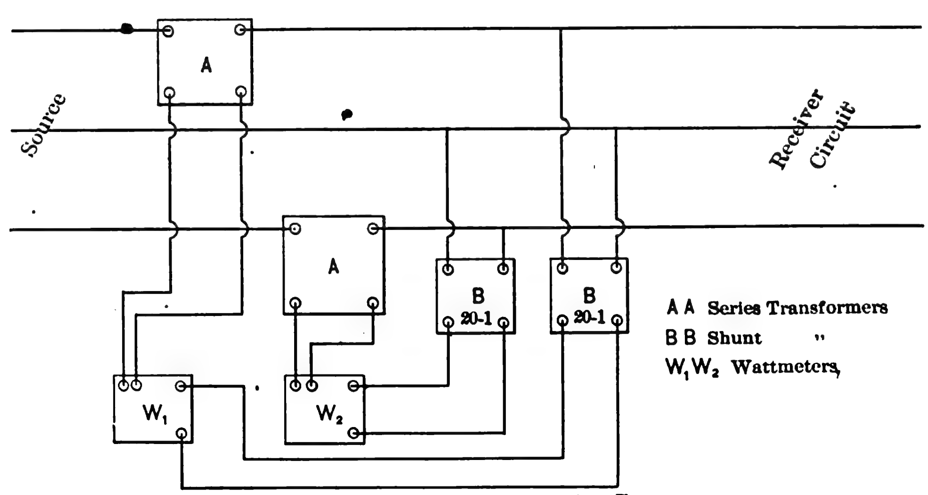


FIG. 3.—MR. SWEETNAM'S SOLUTION.

Mr. Gause's Problem in Bell Wiring.

Enclosed find a solution, Fig. 1, to Mr. Gause's problem in bell wiring published in the September number. By pressing the buttons on the first or third floors, the bell on the second floor will ring; by pressing the lower button on the second floor, the bell on the first floor will ring, and by pressing the top button on the second floor, the bell on the third floor will ring, as required in the problem.

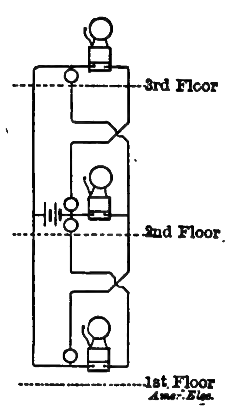


FIG. 1.

Chicago, Ill. A. NELSON.

The same solution was received from L. P. Brodie, Colton, Cal., and W. A. Neafii, Ossining, N. Y.

The accompanying diagram, Fig. 2, is offered as a solution of Mr. Gause's problem in bell wiring: Three 3-point and one two-point push buttons are used. By pushing the button on the first floor, the bell on the second floor rings, and by pressing the button on the third floor the bell on the second floor rings. By pressing the three-point button on the second floor, the bell on the first floor rings, and by pressing the two-point button the bell on the third floor rings.

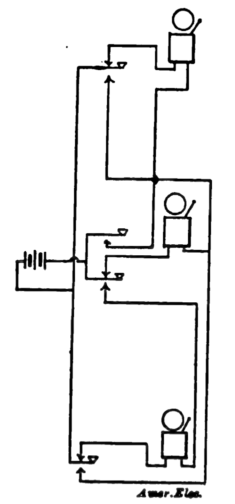


FIG. 2.

C. H. MORRISON.
San Mateo, Cal.

A somewhat similar solution was received from Harry I. Bayers, Jamaica Plain, Mass.

The accompanying diagram (Fig. 3) is offered as a solution of Mr. Gause's problem in bell wiring. The diagram is so plain that no explanation is necessary.

Philadelphia, Pa. CHARLES E. PYLE.

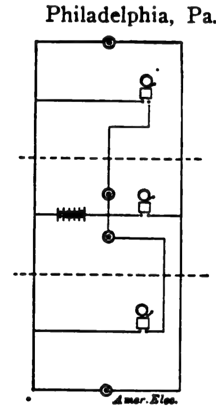


FIG. 3.

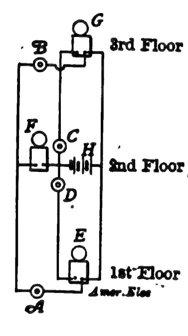


FIG. 4.

Similar solutions were received from Charles E. Bergborn, Fort Hamilton, N. Y.; F. S. Brewer, Newark, N. Y.; W. L. Diffendorf, Akron, Ohio; F. S. Driggs, Athens, Ohio; Clarence E. Faber, Williamsport, Pa.; W. G. Hanson, State Farm, Mass.; Emory E. Jones, Stanford, W. Va.; R. R.

Miller, Grand Rapids, Mich.; A. N. Voss, Milwaukee, Wis.

I would suggest the following as a method for accomplishing the ringing of the bells as per Mr. Gause's problem in the last number: The push button *A* (Fig. 4) rings the bell *F*, the push button *B* rings the bell *F*, the push button *C* rings the bell *G*,

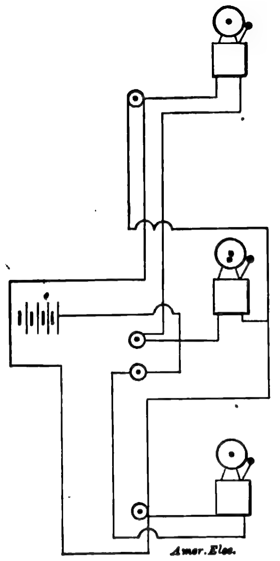


FIG. 5.

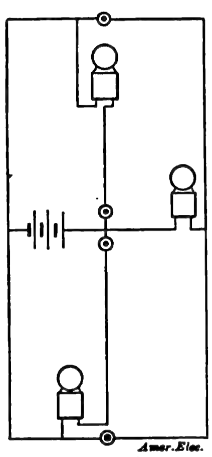


FIG. 6.

and the push button *D* rings the bell *E*.

Meadville, Pa. HARRY DAVENPORT.

Similar solutions were received from Charles Charest, Montreal, Canada; James B. Dillon, Louisville, Ky.; H. A. Fiske, Kingston, R. I.; J. A. Small, Toronto, Ont.

I submit the enclosed diagram (Fig. 5) as a solution of Mr. Gause's problem in bell wiring.

New York City. P. M. RAINEY.

This solution was also furnished by C. C. Coughlin, Rushville, Ind., and H. Painter, Philadelphia, Pa., and is identical with Mr. Gause's solution of his own problem.

The accompanying diagram (Fig. 6) is offered as a solution of Mr. Gause's problem in bell wiring.

Fort Wayne, Ind. K. F. H. FLOERRING.

Similar solutions were received from

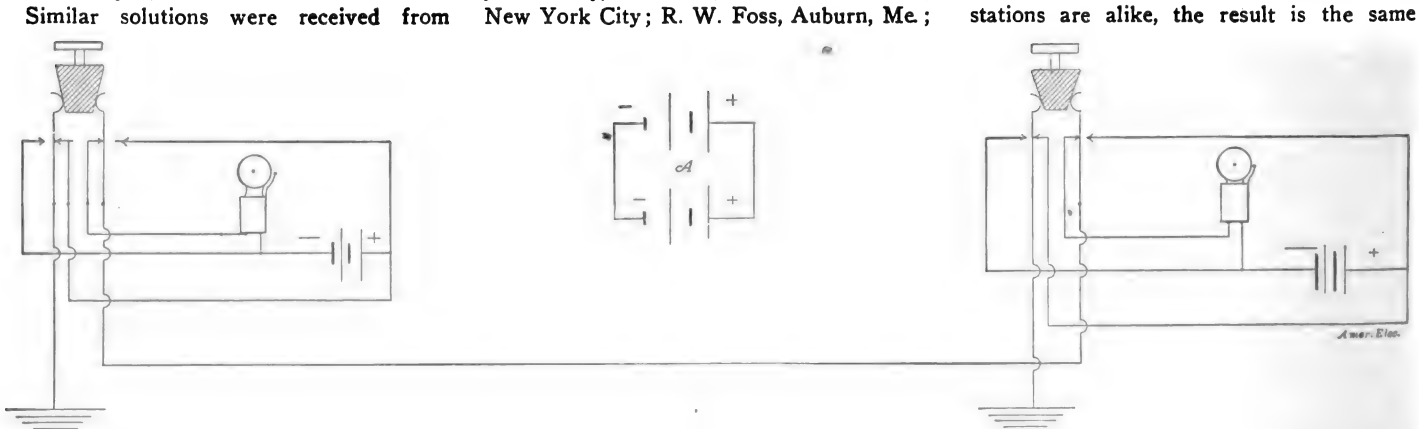


FIG. 3.—MR. BETHELL'S SOLUTION.

George Bates, Lynn, Mass.; W. O. Hendrickson, Argyle, Wis.; Percy Higginson, New York City; H. H. Kennedy, Indianapolis, Ind.; Morris Podell, New York City; Samuel Saeta, Philadelphia, Pa.; Nelson P. Weier, Flushing, L. I.; Alexander Weinberg, Zanesville, Ohio.

I enclose a diagram (Fig. 7) which I

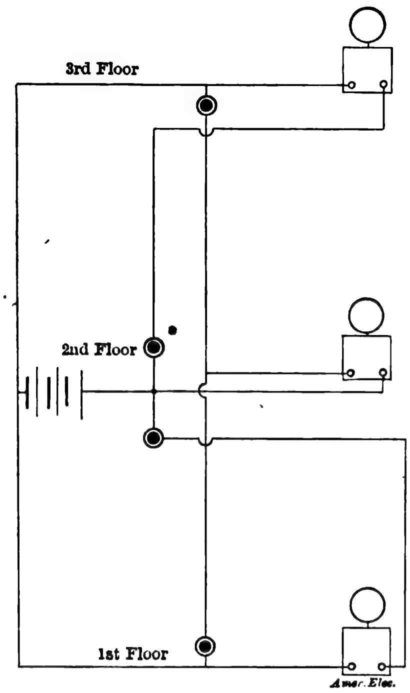


FIG. 7.

trust may be of interest as a solution of Mr. Gause's problem in bell wiring, appearing in the September issue.

New York City. SIDNEY DIAMANT.

Similar solutions were also received from

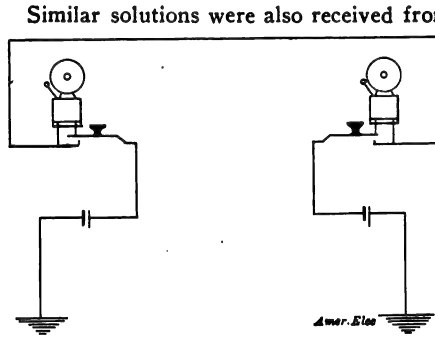


FIG. 1.—MR. HENDRICKSON'S SOLUTION.

J. H. Brady, Baltimore, Md.; Bernard Elias, New York City; R. W. Foss, Auburn, Me.; James H. Lacy, New York City; W. P. Robinson, Detroit, Mich.; Ernest Stevens, Dallas, Texas.

Enclosed herewith find a solution (Fig. 8) of Mr. Gause's problem in bell wiring.

Ft. Leavenworth, Kan. JUNIOR PARISH.

Similar solutions were received from N. P. Bethell, Washington, D. C.; J. A. Brown, Toms River, N. J.; T. A. Daryman, Allegheny, Pa.; A. L Denniston, Salt Lake City, Utah; D. C. McKeehan, Victor, Col.; Wil-

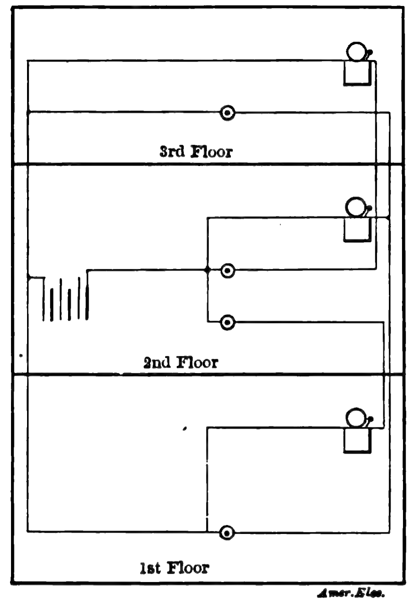


FIG. 8.

son A. McCown, Ladonia, Texas; P. C. Petersen, Fort Monroe, Va.

Mr. Riggs' Problem in Telephone Signalling.

I submit the following solution (Fig. 1) to Mr. Riggs' problem, which I think will answer his purpose. Pressing the key at one station rings the bell at the other sta-

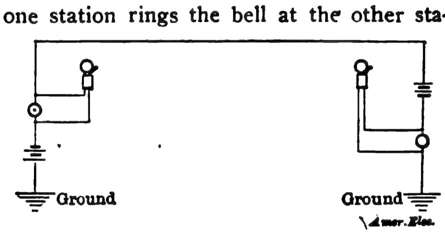


FIG. 2.—MR. KENNEDY'S SOLUTION.

tion. Both batteries are used and since both stations are alike, the result is the same from either end.

Argyle, Wis. W. O. HENDRICKSON.

Similar solutions were received from James S. Lacy, New York City, and Nelson P. Weier, Flushing, L. I.

I submit the following diagram (Fig. 2) as a solution of Mr. Riggs' problem in telephone signalling. A double-contact push button is used to cut out the bell at the station where the signal originates.

Indianapolis, Ind. H. H. Kennedy.

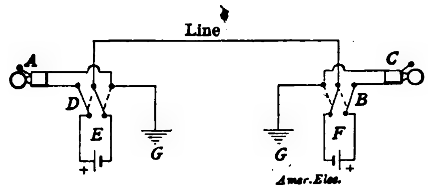


FIG. 4.—MR. RIGGS' SOLUTION.

I offer the accompanying solution (Fig. 3) as an answer to Mr. Riggs' problem in telephone signalling. With the buttons in their normal position, the batteries are connected, as shown at *A*, and when either button is depressed the batteries are thrown in series with the bell at the station being rung.

Washington, D. C. N. P. Bethell.

Similar solutions were received from James B. Dillon, Louisville, Ky., and C. H. Morrison, San Mateo, Cal.

The author's solution is shown in Fig. 4. The pushes, *D* and *B*, are pole changers, and were built in the form of buttons. The batteries are normally opposed, so that no current flows when the line is not in use.

Mr. Frederick's Problem in Telephone Lamp Connections.

The accompanying diagram (Fig. 1) is furnished as a solution to Mr. Frederick's problem in telephone lamp connections published in the September number. When a plug is inserted in jack *A*, springs *L* and *M* will be connected together, and the current flows from the positive side on the battery, through both lamps, *C* and *C*, in parallel, through the spring, *Y*, through the sleeve side of the line *Z*, to the negative end of the battery. When a plug is inserted in jack *B*, the same thing, of course, occurs. With both plugs out, connection with the positive side of the battery is broken, and with both plugs in, connection with the negative side of the battery is broken.

Chicago, Ill. Einar Brofos.

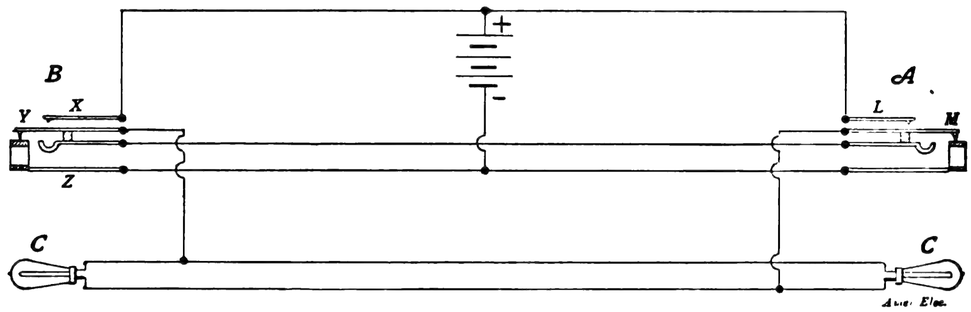


FIG. 1.—MR. BROFOS'S SOLUTION.

I submit the following solution (Fig. 2) to Mr. C. H. Frederick's problem in telephone lamp connections. The contacts of wires 2 and 4 are broken when the plug is inserted in the jack at either end, and the contacts of wires 1 and 2 are made at the same operation. I hardly think any further explanation necessary.

Washington, D. C. N. P. Bethell.

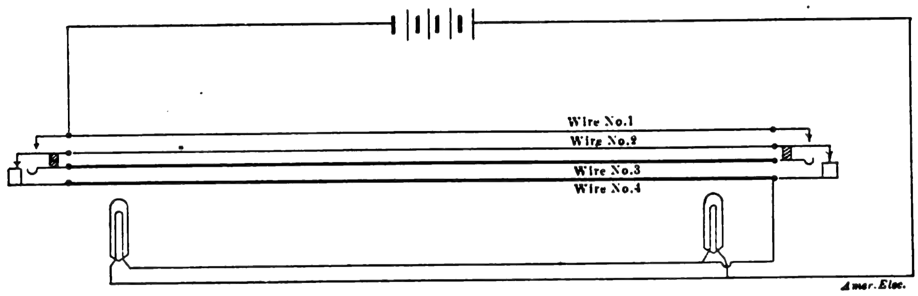


FIG. 2.—MR. BETHELL'S SOLUTION.

Enclosed please find a solution (Fig. 3) to Mr. Frederick's problem in telephone lamp connections. This scheme will work, provided there is no ground on the battery, and it is used as a single circuit.

Toronto, Ont. J. A. Small.

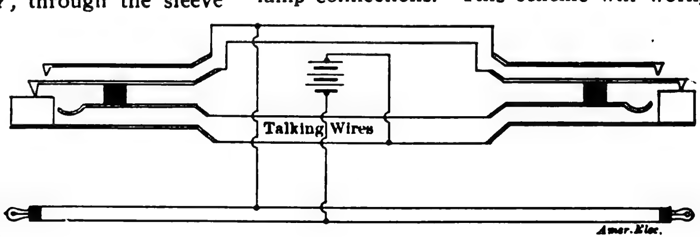


FIG. 3.—MR. SMALL'S SOLUTION.

The following diagram (Fig. 4) is submitted as a solution of Mr. Frederick's problem in telephone lamp connections. The diagram is self-explanatory.

Salt Lake City, Utah. A. L. Denniston.

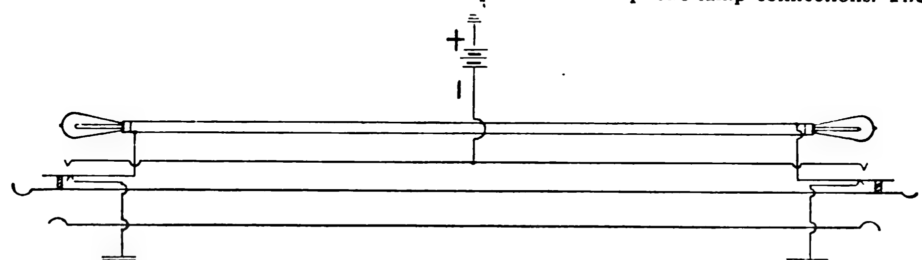


FIG. 4.—MR. DENNISTON'S SOLUTION.

The author's solution is shown in Fig. 5.

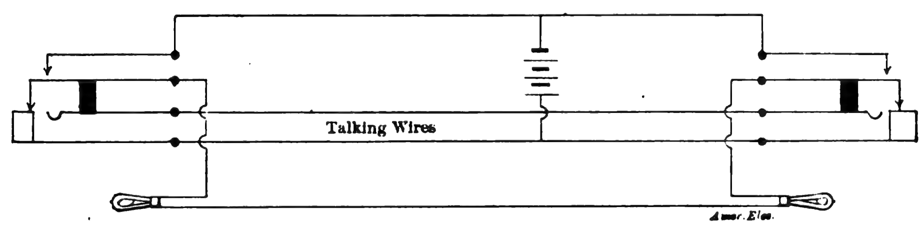


FIG. 5.—MR. FREDERICK'S SOLUTION.

Rise of Potential in Telephone Circuits.

Referring to the peculiar changes of potential in a pulsating ringing circuit, noted by Mr. Bethell in the September issue, I beg to offer the following explanation: It was stated that the e.m.f. of the ringing circuit, unloaded, was 40 volts; that when a 1,000-ohm ringer was operated through a 2-microfarad condenser the potential was 50 volts; and that when the ringer was operated without the condenser the potential would fall to 26 volts, the connections being shown in Fig. 1. I take it that the voltmeter used was a direct-current instrument, and that the pulsating current consisted of uni-directional pulsations alternated with dead periods approximately of the same time interval, and that the ringing lead during each dead period was first opened, then grounded and then opened again, these open

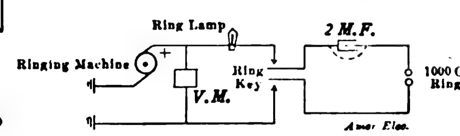


FIG. I.

portions corresponding to the rather large insulating segments separating the live and grounded segments of the commutator, Fig. 2. The direct-current voltmeter reading is an approach to an average potential value,

the needle trying to first go up, then down, then to remain at zero, etc. As the 1,000-ohm bell and its condenser are connected, each pulsation charges the condenser positively toward the positive side of the circuit, and at each of the first open portions

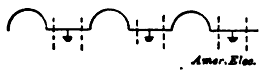


FIG. 2.

of the dead periods the charged condenser discharges back on the line, which sends the current through the voltmeter in a positive direction; so that the voltmeter now receives current pulsations during both current and dead periods, which raises the reading. When the condenser is short-circuited, the self-induction of the 1,000-ohm bell coils comes into play, and during the dead periods the discharge of the coils sends the current through the voltmeter in the opposite direction, causing a lowering of the reading. If an alternating-current voltmeter is placed in parallel with the direct-current voltmeter, then in the first case, when the direct-current voltmeter reads high the alternating-current voltmeter will also read higher than it did before the bell was operated, but in the second case, when the direct-current voltmeter drops, the alternating-current voltmeter will still read higher, since current through it in either direction affects the needle the same.

Thos. Addison Nathans.
Fordham, N. Y.

Referring to the problem submitted by Mr. N. P. Bethell, I would say that the rise in potential is due to the discharge of the condenser, the condenser being in series with the sources of e.m.f., so that the potential of this at discharge must be added to the potential of the ringing machine.

A. L. Denniston.
Salt Lake City, Utah.

I would suggest that the rise in potential on Mr. Bethell's telephone circuit was caused by a leading current. When the circuit is opened there is no drop through the armature of the generator, and the normal voltage is obtained. As soon as the condenser and bell are connected in the circuit, a leading current flows through the armature. The magnetism produced by this leading current reinforces the magnetism of the field magnet, hence the increase in voltage is greater than the drop through the armature. When the condenser is cut out a lagging current is produced and its magnetism weakens that of the field. This and the armature drop cause the voltage drop.

Granite, Ill. Harry C. Coates.

The result obtained by Mr. Bethell would seem to be about what one would expect. Throwing in the condenser causes a rise in voltage of the impulse wave, which is almost analogous to a wave of water striking a rock-bound shore, so that the voltage is higher with the condenser than without; or, in other words, the voltage is lower where the wave passes around the circuit unimpeded.

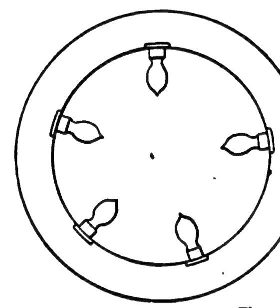
Grand Rapids, Mich. R. R. Miller.

Diversified Power Plant Experience.

Having obtained much helpful information through the Letters Department of your valuable paper, leads me to believe that a leaf or two from my own diary of experience might be the means of helping some one else out of some of the close corners in which all engineers during the course of their lives find themselves. Not many years ago I was employed in a steam plant having three units, two of 250 horse-power and one of 1000 horse-power; the former driving 200-kw. generators and the latter a 700-kw. machine. All the units were in operation during the period of heavy load, and as the load dropped off one of the small units was cut out, then the large unit, and finally the other small unit. This caused one of the small units to be the first to be cut in service and the last to be switched out. When starting up the first small unit one morning, the machine, to our surprise, built up to 50 volts, but would go no higher; the line voltage was 600. Every part of the generator was carefully gone over and it seemed all right, so the engine was stopped for the purpose of making a closer inspection. One of the assistants by chance caught hold of one of the shunt field connections, and the wire pulled out of the coupling very easily. On examination it was found that the screw holding it in place had backed out far enough to let the wire just touch and form a very poor contact. After tightening up the screw the machine was put in operation again and built up quickly.

While employed in another plant, I had a like experience with a machine which would not build up; but the trouble was found in a different place. This particular machine was the last to be shut down at night and the second to be cut in on the line in the morning, and it would not build up at all. From my previous experience I surmised that the trouble might be in the field and brush connections; but upon examination nothing was found wrong. I came to the conclusion then that the trouble must be on the feeder board where the machine switches and rheostat were located. On making a hasty examination nothing appeared wrong; but on looking at the rheostat on the back of the board I noticed a thick scum on the segments. I took a piece of sandpaper and cleaned the shoe and segments and then gave the machine another trial. This time it built up without any trouble, and I made up my mind that after that the rheostat needed attention as well as the other apparatus and would be inspected regularly. I think that while the rheostat was warm the shoe made contact; but when it got cold after shutting down the scum acted as an insulator.

At another place where I was in charge the factory was equipped with motors and the current was furnished by the local light and power company. An assistant was detailed to look after the motors and shafting and one morning he reported that one of the motors refused to start. I made an examination of all the connections and could find no reason why the machine should not run when current was applied. I asked the assistant what he had done prior to shutting down the night before, and he informed me that he had wiped the commutator as usual, using a clean piece of cloth, as the old piece was dirty. On examining the cloth I quickly found what the trouble was. In a sheet-iron cabinet we kept paint, oil and shellac together, with some clean oil for wetting the cloth to wipe the commutator with. It happened that on the day in question some one had used the shellac and placed it where the oil was usually kept. The tender in his hurry to shut down and get out did not notice the difference, and wet his cloth with shellac instead of oil. This he applied to the commutator after the current had been turned off, and it naturally formed a good insulator between the commutator and the



HOME-MADE REFLECTOR.

brushes. The main belt was thrown off and the armature turned by hand while a piece of sandpaper was held against the commutator. After thoroughly cleaning the commutator the belt was replaced, current turned on, and the motor ran as smoothly as ever.

Some of your readers may have at some time or other the hard luck of having a superintendent who sticks to old ways, regardless of the time and worry it costs the engineer. This was my lot in the plant first mentioned. There was a small blacksmith shop where most of our repair work was done, such as bushing or babbitting pulleys; in fact, we gave out very little of our repair work. This shop was located in a dark corner of the factory and the only light obtainable was from five 16-c.p., 110-volt lamps. I had repeatedly asked for reflectors to put on the lamps, and although the cost of these was small they were not forthcoming. I made up my mind after waiting some time to make one, and to rearrange the wiring so that I could form a cluster of the lights and arrange them so that they could be moved to any part of the room and lowered or raised to suit the work by means of a cord. I took a tin pan about 20 inches in diameter and cut a ½-in. board to the radius of the bottom of the pan and fastened this to the outside of it. I fastened blocks of wood on the inside, as shown by the sketch herewith, to fasten the sockets to, and cut a hole through the bottom of the pan to allow the wires to pass through. This worked satisfactorily and gave a good light for a long time until I finally got a reflector.

W. A. Dow.
Cambridge, Mass.

Questions and Answers

Inquiries not accompanied by the name and address of the inquirer, will not receive attention.

Is it practicable to operate a 500-volt 100-kw. generator connected to the outside wires of a three-wire circuit which is already being supplied by four 250-volt generators of smaller size, taking care of the unbalancing by means of the smaller machines? C. S. B.

Yes.

Please give instructions for changing a small single-phase induction motor, built for 104 volts and 125 cycles, so that it will operate on a 60-cycle circuit of the same voltage. J. M. E.

It is not practicable to make the change with satisfactory results.

If a person thoroughly insulated from the earth should take hold of a high-potential line, would he feel any sensation when his body became charged electrostatically? D. M.

Not unless he was sufficiently near to the earth to permit a discharge to pass from him to it.

What is the magnetic density usually employed in the air-gap of a 25-cycle induction motor? (2) Would a 25-cycle induction motor be larger than a 60-cycle machine of the same type? T. B.

From 40,000 to 60,00 magnetic lines of force per square inch, according to the type of design. (2) Yes.

Will two induction motors work well together belted to the same shaft? G. E. M.

Yes, provided the pulley ratios are properly proportioned and the machines have the same characteristic so that the relation between their speeds will remain constant at all loads.

Why is the distinctness of speech on a telephone circuit impaired when the wires are put in long cables? R. W. F.

Because the telephone wire and the sheath of the cable act as a condenser which absorbs a great deal of the effectiveness of the fluctuating current, thereby reducing the current available for the operation of the telephone receiver.

Which will pass more current, a single 110-volt lamp or two 110-volt lamps in series, the lamps being of the same type in both cases and the terminal voltage being the same? (2) Why is iron used for collector rings of revolving-field alternators instead of copper? H. W. F.

The single lamp will take more than twice the current that two similar lamps in series will take connected to the same circuit. (2) Because it is cheaper and more durable.

Please give data for an induction coil to give a 6-in. spark for wireless telegraph purposes. E. D. S.

Core, 1¼ ins. diameter by 12 ins. long, built up of No. 22 annealed iron wires; primary winding, two layers of No. 12 wire; secondary winding, 7 pounds of No. 36 wire; divide the secondary into at least four sections and preferably six. Put 60 sheets of tinfoil, each 6 ins. x 10 ins. in size, in the condenser.

How can the voltage and output capacity of a generator be ascertained without testing the machine when it has no name-plate? E. J. B.

It is impossible to make such a determination with any approach to accuracy. The output capacity in amperes may be roughly estimated by adding up the brush face contact areas and multiplying the sum of these by 20. It is practically impossible to estimate the voltage without a thorough knowledge of the armature winding, or without testing the machine at a rational speed.

Is it impossible to parallel single-phase alternators, and if so, why? (2) If it is possible to operate single-phase machines in parallel, what is the objection to doing so? (3) What is the approximate difference in size between a single-phase machine and a polyphase machine of the same rated output and speed? J. M. D.

Not if the machines are of modern design. (2) There is no objection except the inconvenience of throwing the machines into circuit in parallel. (3) There is not even an approximate ratio which holds good throughout any considerable range of sizes, and the ratio for any given size depends almost entirely upon the character of the design. It is easier to compare outputs for a given size of frame; a given frame with a polyphase winding will yield from 10 per cent to 30 per cent more output than with a single-phase winding of the same general type.

How is the resistance of a dynamo armature measured? (2) What horse-power is required to drive a dynamo delivering 630 amperes at 118 volts with an efficiency of 91 per cent.? (3) What is meant by an alternating current having a frequency of 60 cycles? (4) What is meant by the statement that a storage cell has a capacity of 1,000 ampere-hours? F. W. M.

The simplest and most reliable method is to pass current through the armature while it is standing stationary, regulating the current flow by means of an external adjustable resistance so as to keep the current well below the maximum capacity of the armature. Then measure the current and measure the voltage at the brushes simultaneously. Dividing the voltage by the current gives the resistance in ohms. (2) The output is $118 \times 630 = 74{,}340$ watts, which is equivalent to 99.65 horse-power. The efficiency being 91 per cent., the applied horse-power is equal to $99.65 \div 0.91 = 109.5$ horse-power. (3) A current which changes from positive to negative and back again sixty times in one second. (4) It usually means that if the cell is charged at its normal rate, when the charging current multiplied by the number of hours equals 1,000 it will be fully charged.

What is meant by the "pitch" of an armature winding? (2) Why are inductor alternators considered inferior to the usual type? J. L. W.

There are several "pitches" in an armature winding, none of which is it in the least necessary to consider. The front pitch is the number of steps, reckoned in armature conductors, from a given active conductor to the active conductor to which it is connected at the commutator segment; the back pitch is the number of steps from a given active conductor to the other active conductor of the same loop or coil to which it is directly connected across the back of the core. The commutator pitch is the true guide to the winding; it is the number of steps, reckoned in commutator bars, from one terminal of a coil to the other, after the coil is connected up. Thus, in a simple lap winding where the two terminals of each coil go to adjacent commutator bars, the commutator pitch is 1; in a wave-connected winding having 8 bars between the two to which the terminals of one coil are connected, the commutator pitch is 9. (2) Because of their poorer regulation.

What is the effect of lifting one or two sets of brushes on a six-pole dynamo carrying a light load? (2) What is the effect on a multipolar dynamo having one or two air-gaps larger than the others? (3) I have considerable trouble with grounds in conduit wiring supplying current to electric dumb waiters. The circuit is sometimes opened while a machine is at full speed, thereby stopping it suddenly. Would this cause grounds? I. H. K.

The effect would depend on the type of armature winding employed; if it is a wave winding, no harm would be done by lifting some of the brushes while carrying a light load. If it is a simple lap winding, no harm would be done unless the load actually carried was a greater proportion of the full load than the proportion of the total number of brushes remaining in service. (2) The magnetic pull on the armature becomes unbalanced, increasing the journal friction and wear, unless it happens that there is an even number of excessive air-gaps, and these are diametrically opposite each other in pairs. If the armature is lap-wound, without any equalizer connections, differences in air-gaps will cause local currents to flow in the winding and overheat it. (3) If the connections are such that opening the supply circuit will not allow the shunt fields of the motors to discharge through a closed path, the field discharge may puncture the insulation and cause the grounding.

What is a time relay? (2) What is an I. R. T. regulator and what is it used for? (3) Why are I. R. T. regulators not used in railway practice? (4) What causes high and low bars in a commutator? (5) What causes commutator bars to show a slight dark mark, irregular in shape, at the back end, close to the mica? (6) Can the speed of a rotary converter be varied by adjusting its shunt field excitation? (7) Why are motor balancers used in some of the Edison sub-stations instead of carrying the neutral conductor of the direct-current distribution to the middle point of the secondary windings of the transformers? W. H. S.

See Mr. Fernandez' article in the September number. (2) A three-phase regulating transformer, the primary of which is adjustable with relation to the secondary so as to vary the secondary voltage or even reverse it with respect to that of the circuit. It is used for adjusting the pressure on individual feeders supplied from a common set of bus-bars; also to regulate the voltage delivered to rotary converters and thereby regulate the direct-current delivered by the converters. (3) It is used in railway practice in the manner just stated. (4) The drying out of the insulating material between the bars and at the ends of the commutator. (5) Imperfect commutation; it is impossible to give the cause of the bad commutation without knowing all of the local conditions. (6) No. (7) Because closer regulation is obtainable by means of motor balancers.

NEW FT. WAYNE SERIES ALTERNATING ARC LIGHTING SYSTEM.

The Fort Wayne Electric Works, Fort Wayne, Ind., has developed a complete system for series arc lighting circuits to be operated from a constant-potential supply. The system consists broadly of a regulator for maintaining constant current, a specially designed high-tension switchboard, a constant-potential transformer and the series

FIG. 1.—REGULATOR FOR SERIES ALTERNATING-CURRENT SYSTEM OF ARC LIGHTING.

arc lamps. Both sides of the line are equipped with lightning arresters especially adapted to circuits of this nature.

Fig. 1 represents the regulator which has been designed for this system. Its operating principle is the familiar one of the automatic introduction of impedance into the lamp circuit whenever any decrease in the resistance of the latter would tend to cause an excessive current to flow therein. In details, however, the system differs from previous ones. The impedance is introduced by the combined movements of a laminated iron core and an impedance coil into such positions as to cause a greater magnetic flux to be cut by the conductor in the coil when the current is excessive; this, of course, produces a choking effect, reducing the current to its normal value. If for any reason the line current be decreased, the opposite action takes place and the current is automatically increased to its normal value. The mechanical parts of the regulator are said to be so arranged that the motion of the heavy core is small as compared with that of the coil, reducing the effect of inertia in the parts and giving more sensitive regulation. The core and the coils counterbalance each other, obviating the use of counter-weights. No attention is required at the regulator, the starting operation being entirely controlled from the switchboard specially designed for this purpose.

The switchboard consists of a single panel of blue Vermont marble, equipped with an ammeter, a reactance coil, fuses, and all necessary switches for the starting and control of the system. It can be furnished with or without a wattmeter sub-base equipped with an integrating wattmeter. The diagram, Fig. 2, shows the arrangement of circuits, etc., by means of which the system may be quickly put into operation from the switchboard. It is claimed that the system may be started up without causing any disturbance on the supply line. The starting switch, which is located in the center of the panel, should always be closed last. In the closing of this switch, three distinct conditions are produced. First, the reactance, which is mounted upon the back of the switchboard, is introduced into the regulator circuit, so that no rush of current will take place when the regulator is thrown upon the line. Next, the switch short-circuits the reactance, thus throwing the regulator, which has by that time reached its full load position, directly across the constant-potential bus-bars. During both of these operations the line leading to the arc lamps is short-circuited; when the starting switch is entirely closed, the short-circuit across the line is removed, putting the arc lamp system in normal operation. By thus connecting the lamps into the circuit after normal current has been established no disturbance is caused in the mechanism of the lamps.

Although the systems for 12 and 25 lights will operate satisfactorily without the use of a constant-potential transformer upon circuits of 1100 and 2200 volts respectively, it is advisable to use a transformer in all cases, even though it be of one-to-one ratio, merely for insulation purposes. This is especially desirable where both arc and incandescent systems are operated from one set of bus-bars, in order to insulate the arc system completely from that which supplies the incandescent lamps.

FIG. 3.—CONSTANT-POTENTIAL TRANSFORMER.

Fig. 3 represents a constant-potential transformer for use with this system; it may be either step-up or step-down, or it may maintain the same voltage upon the secondary that is supplied at its primary terminals in cases where it is introduced for insulation purposes only. The secondary of the transformer is provided with a number of taps, by the use of which the output may be varied as more or fewer arc

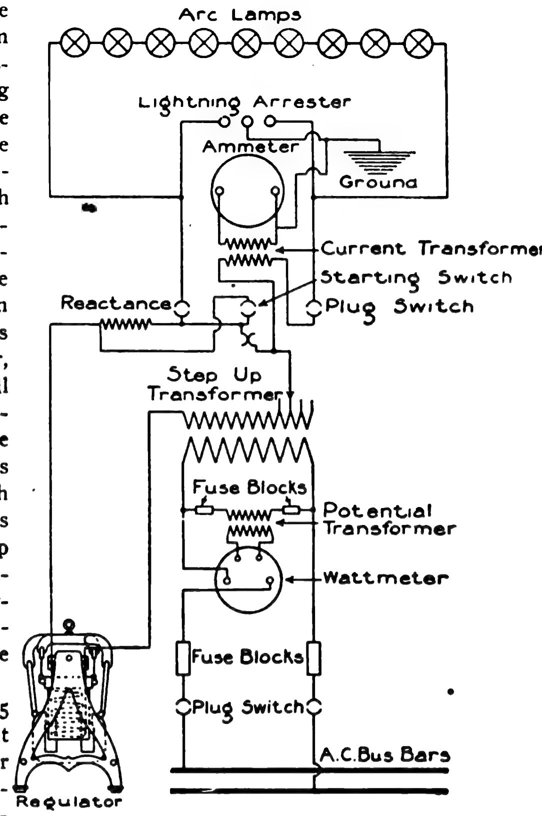


FIG. 2.—DIAGRAM OF CONNECTIONS FOR SERIES ALTERNATING-CURRENT SYSTEM OF ARC LIGHTING.

lamps are operated on the circuit, thereby maintaining a close approximation to full-load efficiency and power factor under the most unfavorable conditions.

The arc lamps which have been designed to operate in connection with this system conform to the high standard of the Fort Wayne direct-current lamps. They will operate at extremely low temperatures for 125 hours with one trimming, when adjusted for the normal current of 6.6 amperes. In the design of these lamps great care has been taken to prevent vibration and the consequent hum which frequently occurs in lamps operated on alternating-current circuits.

The system has been designed for either 60 or 140 cycles. The 140-cycle lamp has been especially designed for high-frequency service and cannot be operated on a 60-cycle circuit. Although the use of the 60-cycle system is advised wherever possible, owing to the fact that it is at present the tendency of central stations to reduce the frequency of their systems, the high-frequency lamp has been perfected in order that central station managers who already have 140-cycle circuits in use may be enabled to use this system.

New Apparatus and Appliances

STEEL-FRAME MULTIPOLAR BELTED MOTOR.

The, accompanying engravings illustrate a new line of steel-frame multipolar motors brought out by the Triumph Electric Com-

FIG. 1.—35-H.P. TRIUMPH MOTOR.

pany, of Cincinnati, Ohio. These motors are made either shunt, compound, or series wound, according to the service for which they are intended. They are adapted equally well to operate line shafts, machine tools, printing presses, laundry machinery, cranes, hoists, elevators, pumps, fans, or in fact, any sort of apparatus. The frame is made of close-grained steel, resulting in a very compact machine, and the brackets are centered against the crown and firmly held in place by steel bolts. The poles are also of steel and equipped with a special design of laminated shoe to provide the necessary magnetic fringe. This is said to result in sparkless operation, cool running and high efficiency. The bearings, which are of special bearing metal, are of the self-oiling, self-aligning type; they are made to gauge and reamed so as to be interchangeable and easily replaced. Oil wells of ample capacity

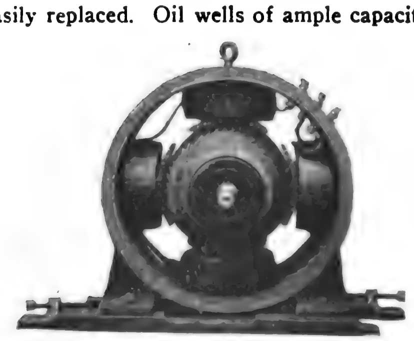


FIG. 2.—MOTOR WITH END PLATE REMOVED.

are provided in each pedestal. The armature is of the iron-clad laminated-core tooth type. The laminated discs are annealed and japanned after being punched and are then mounted and keyed directly on the shaft. The armature coils are form-wound and each consists of a continuous length of copper with no joint except where connected with the commutator. Each coil is insulated and tested before being placed in position, and alternate layers of heavy fuller board, mica and oiled linen are provided in the slots as additional insulation. The commutator is made up of drop-forged copper, the bars having great depth. The bars are mounted upon a cast-steel shell of such construction that it is said to be impossible

FIG. 3.—ARMATURE OF 10-H.P. MOTOR.

for them to move or for the commutator to get out of true. The bars are insulated from this shell and from one another by mica. With a view to making the machine as compact as possible, both ends of the armature are so arranged that the pedestals may project under them. An improved oil guard is provided, which it is claimed, makes it impossible for any oil from the bearings to enter the armature or commutator. The fields are all form-wound, thoroughly baked and insulated with fuller

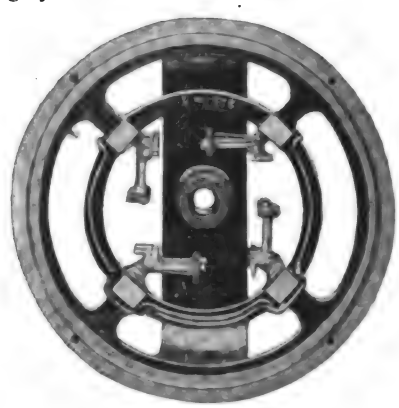


FIG. 4.—COMMUTATOR BEARING SHOWING BRUSH RIGGING.

board, mica, canvas and insulating varnish. During construction and after being placed in the machine, each coil is tested with 2,000-volt alternating-current. The brush-holders are of simple yet effective design. Carbon brushes are used, and these are rigidly attached to the holder, proper adjustment being secured by a tension spring. The brush rigging is carried over the front end of the crown instead of on the pedestal. The holders are convenient of access, and the yoke, when properly set, is held in position by a lock screw. The motors are said to be capable of withstanding heavy overloads and sudden fluctuations of load. They

FIG. 5.—MOTOR WITH IDLER ATTACHMENT.

can be readily arranged for either floor, wall or ceiling use, and their compact form and light weight permit them to be mounted directly upon the machine to be driven. With short belt drive the motor can be placed on very short centers, a flexible idler being provided, as shown in Fig. 5, which increases the belt surface on the pulley and overcomes the slackness of the belt.

NEW 500-VOLT RECEPTACLE.

Figs. 6 and 7 show two new receptacles brought out by P. H. Fielding, of Trenton, N. J. The design does away with the necessity of soldering and taping the lugs and also provides additional insulation, so that short-circuits in the receptacle are hardly possible. The manufacturer calls attention to the following points of merit:

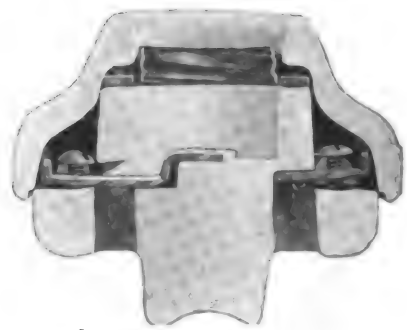


FIG. 6.—500-VOLT LAMP RECEPTACLE.

Flange on copper screw shell makes it very strong; No. 16 B. & S. washer held by three No. 4 screws on top of the flange of the shell makes it rigid; separation between shell and center contact is over ½ inch; the porcelain cap covering the binding screws also covers the top of the lamp base; the cap is held in place by two screws and there is no porcelain ring to break; the wires are kept a proper distance from the surface by the porcelain extension; the screws fast-

FIG. 7.—RECEPTACLE FOR OUTDOOR USE.

ening the receptacle are over an inch distant from any live wire; an air space between the receptacle and surface is provided to dry up any moisture; considerable time is saved in installing the receptacle. The engravings show the construction very well.

IMPROVED CARBON BRUSH CONNECTION.

The National Carbon Company, of Cleveland, Ohio, has brought out an expansion connection for carbon brushes for which many advantages are claimed. A carbon brush, of any size, has a hole drilled into it, penetrating about one-half of the brush. A piece of plaited flexible wire, terminating in a cable shoe, is unraveled at the end opposite to the cable shoe, and this miniature wire net is formed cylindrically around a little brass sleeve. This

sleeve is of the same length as the hole in the carbon brush, and is slotted over two-thirds of its length. The slot is tapped so that the closing screw fitting into the slot is forced into a tapering hole. The resistance with which the screw meets on account of this tapering is overcome by the sleeve expanding so that the whole appliance acts as a wedge when the screw is inserted, making a very close and rigid contact between the flexible wire and the interior of the brush, which is even increased through expansion of the metallic parts, should the brush become slightly heated while in use. This flexible connection is very easily detached and can be connected to a new brush simply by use of a screw driver, obviating the necessity of attaching by means of the soldering process. This connection is so arranged that the distance between the commutator surface and the terminal connection is reduced to a minimum, thereby reducing the carbon resistance between these points, resulting in obtaining a higher efficiency and a lower loss between the commutator surface and the end of the connection.

THE MABBS ELECTRIC ELEVATOR.

An elevator, which is a radical departure from previous electric elevators, has been designed by John W. Mabbs, of Chicago, Ill., and is shown by Fig. 8 herewith. The essential feature of the Mabbs elevator is that the motor forms the counter-weight and travels up and down a counter-weight shaft instead of being located permanently in the basement. The motor and other mechanism which form the counter-weight, however, differ from the ordinary counter-weight in that instead of depending on the cable altogether for support, the motors are geared to a vertical rack, so that it has at all times a positive mechanical connection with the sides of the shaft. The counter-weight is, therefore, raised and lowered by means of the motors operating on this rack and pinion. The motor, which is of a special design, has a vertical shaft and is geared through a worm gear to two horizontal shafts. Each horizontal shaft has a pinion on each end, making in all four pinions, which engage in four vertical racks. The racks are mounted upon the outer faces of two cast-iron columns. The motor mechanism hangs from a sheave around which the cables pass, as shown in Fig. 8. By this arrangement the elevator car, of course, travels two feet to each foot of motor travel. The motor hatchway, therefore, extends half the height of the building. The motor machine runs in guides on the inner faces of the cast-iron columns. Current is carried to the motor through copper-lined channel irons, mounted on porcelain block insulators situated on the columns between the motor guides and the racks.

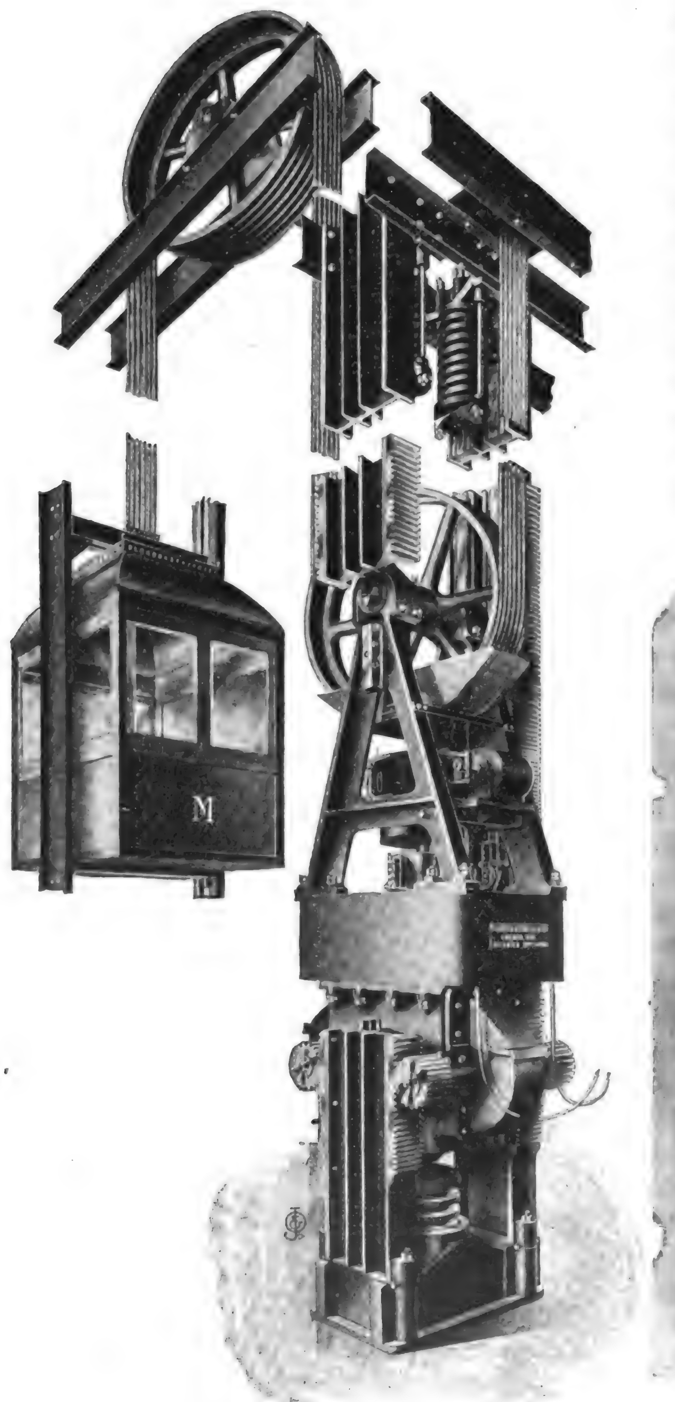


FIG. 8.—MABBS ELECTRIC ELEVATOR.

"UNIT" TYPE OF OIL FILTER.

Fig. 9 herewith shows a sectional view of the "Unit" type of American oil filter built by The Burt Manufacturing Company, of Akron, Ohio. In operation the dirty oil enters the waste oil receptacle and passes through small perforations, flowing thence horizontally to two filtering cylinders. In passing to the cylinders the heavy impurities fall into the sediment pan and therefore do not clog up the filtering cloths of filtering material. Each cylinder is wrapped with a cloth through which the oil must pass before entering. After passing through a quantity of bone black, the oil flows through two tubes in the bottom of the filter. By means of plates attached to the bottom of the tubes, the oil is spread out in a thin film and is washed by the water, so that any remaining impurities in

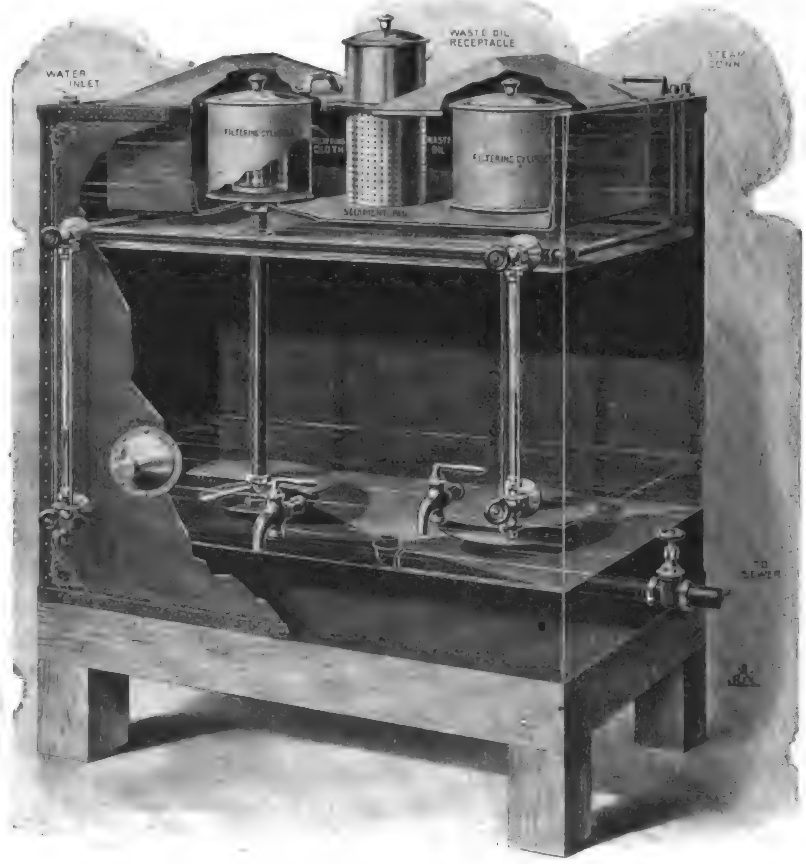


FIG. 9.—"UNIT" TYPE OIL FILTER.

the oil tend to drop to the bottom of the filter, where they may be flushed out by opening a gate valve connecting with the sewer. The manufacturer calls special attention to the hot water chamber in the upper part of the filter. This feature is covered by patents. The object in heating the oil before filtering is to render it more fluid and thus increase the speed of filtration. The filter is guaranteed to handle the heaviest grades of oil.

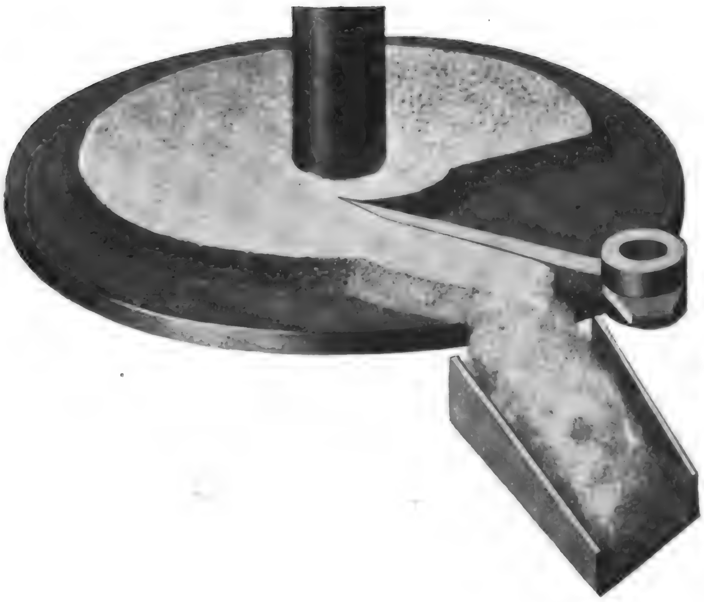


FIG. 10.—MECHANISM FOR INSURING REGULARITY OF DISCHARGE.

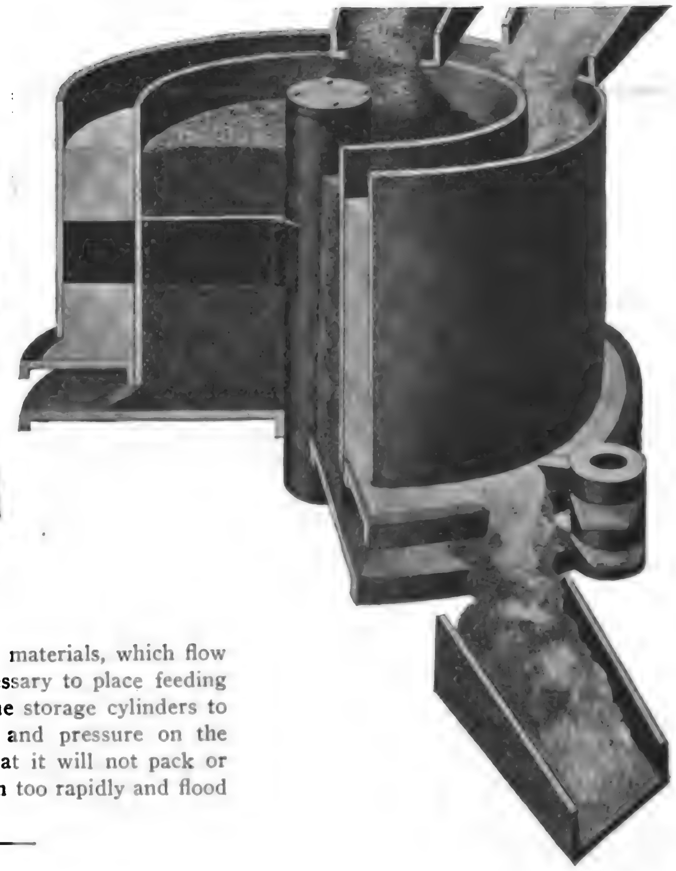


FIG. 11.—SECTIONAL VIEW.

AUTOMATIC MEASURING AND MIXING MACHINE.

The Link-Belt Engineering Company, of Philadelphia, has brought out a continuous measuring machine, which is adapted to feed one substance or to proportion the several ingredients of a mixture. The measuring machine, which was devised by E. N. Trump, consists essentially of a horizontal revolving table, on which the material to be measured rests, and a stationary knife set above the table and pivoted on a vertical shaft outside the circumference. This knife can be adjusted so as to extend the proper distance into the material on the table, at each revolution of which it peels off a certain amount, which falls over the table edge into the chute. This is shown in Fig. 10. The amount of swing of the knife is controlled by a screw attached to an arm, cast as part of the knife, and a micrometer scale with pointer shows the amount of movement. Where it is desired to measure off and mix two or more materials, the machines are made with two or more tables, set one above the other, and mounted on the same spindle so that they revolve together, each table having its own storage cylinder above it, and the cylinders being placed one within the other as shown in Fig. 11. For each table there is a knife, with its own adjusting mechanism, which allows the user to vary, at will, the percentage of each material in a mixture; and, as the materials flow together constantly and regularly in small streams as they drop down the common chute, each amount of one ingredient is accompanied by the proper amounts of the other ingredients, and the particles become intimately mixed. In feeding materials to the storage cylinders of these machines a conveyor is necessary merely to see that enough is kept in the storage cylinders so that the amount which the knives peel off will be constant. With some finely powdered materials, which flow very freely, it is necessary to place feeding seals at the top of the storage cylinders to regulate the density and pressure on the material below, so that it will not pack or flow out at the bottom too rapidly and flood the table.

NEW POLE LINE FUSE BOX.

The H. W. Johns-Manville Company has brought out the pole line fuse box, shown by Fig. 12 herewith, for use on 2,500-volt distribution systems, in connection with Sachs "Noark" fuses. The external casting consists of a cast-iron box having a hinged cover opening sideways. The cover is provided with a rubber gasket, which forms a weather seal between the box proper and the cover, which latter is firmly held in position by the thumb nut hasp. Inside of the iron box is a porcelain box provided with a porcelain cover and fuse holder. When in place the cover is flush with the top surface of the porcelain box, and finds a seat on a rubber gasket placed in a ledge around the inside of the outer walls of the porcelain box. The fuse is held to the cover by means of the well-known "Lobster Claw" device, which consists of a pair of tongs made of a specially treated insulating material, manipulated so as to clamp or release the fuse by means of a nut embedded in the porcelain handle, on the exterior of the cover. This nut works on a stud projecting from the clevis to which the claws are attached. Turning the nut in one direction causes the claws to be brought together to clamp the fuse, so that it is firmly held to the blocks on the porcelain cover. Movement in the opposite direction permits the spring to open the claws and release the fuse. When clamped to the cover, the fuse and cover are manipulated as one device and form practically a plug co-acting with the contacts attached to the base portion of the porcelain box. The fuses are fitted with the so-called type "C" contacts, which consist of flat blades on each side of the fuse tube, forming a knife-blade switch contact. The receiving clips on the base of the porcelain box are

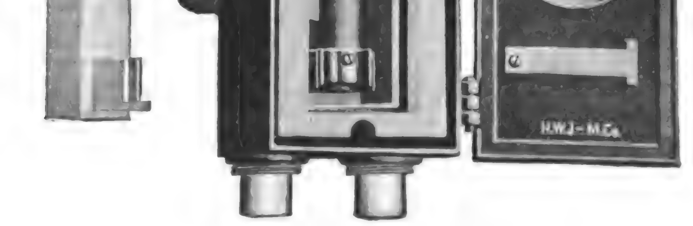


FIG. 12.—POLE LINE FUSE BOX.

made of spring metal and the insertion of the fuse into them is readily accomplished. The arrangement is such that the box is practically closed just before the fuse reaches the contact clips. A novel feature embodied in this box is the method of connecting the box to the line and entirely protecting the current wires from contacting with any of the metal parts of the box. The wires enter the box through porcelain bushings at the bottom of the iron casing. These porcelain bushings are held in position by means of brass rings, which force the head of the porcelain against the bottom of the porcelain box with a rubber gasket intervening. A water-tight joint is, therefore, made. Attached to the clips in which the fuse is received, are brass castings which are so located that the hole in the castings also aligns with the hole in the wall of the box. It therefore becomes a very simple matter to insert the wire. The wire is clamped, after it has been properly placed in the hole of the connecting post by screws easily reached by an ordinary screwdriver. It will be noticed that after the wire once enters the porcelain bushing on the bottom of the box it is entirely surrounded by porcelain, and is perfectly protected from leakage or contact with the non-current-carrying parts of the box.

COMBINATION VOLT-AMMETER.

The Connecticut Telephone & Electric Company, of Meriden, Conn., has placed on the market a new type of volt-ammeter, which is illustrated by Fig. 13. The instrument, which has been designed especially for testing batteries, is made up in two styles—one a combination volt-ammeter and the other reading in amperes only. The scales are graduated from 0 to 30 amperes

FIG. 13.—COMBINATION VOLT-AMMETER.

and from 0 to 6 volts, and are carefully calibrated. The arrangement of the needle supports is said to permit very delicate and accurate reading.

HIGH FREQUENCY ALTERNATOR.

A high-frequency alternator for laboratory experimentation has just been furnished the American De Forest Wireless Telegraph Company by the Peerless Electric Company, of Warren, Ohio. The machine is of two kilowatts capacity, 110 volts at 833 cycles, though in extended tests at the factory it was run for hours at a frequency as high as 5,000 cycles. In designing this generator the engineering department adopted the inductor type, the laminated stationary armature having 200 slots and the rotor one-half that number of teeth. Especial attention was given the mechanical design, to insure stability of all parts. The rotor, which is twenty-five inches in diameter, was made of two rings of steel each forged from a solid piece of metal, the periphery being slotted to form the poles. These rings were shouldered and assembled on a heavy steel disc, through the hub of which passed the shaft of tool steel. Heavy phosphor-bronze bearings are used, lubricated by ring oilers.

CATALOGUES WANTED.

J. Don Alexander, of Keokuk, Iowa, is about to engage in the electrical contracting and supply business, and intends to keep a large stock. He requests from manufacturers and dealers in electrical supplies and appliances latest catalogues, literature, etc., and price lists.

THE STIRLING-CAHALL BOILER COMPANY

A consolidation of interest to the engineering world has just been consummated by the amalgamation of the water-tube boiler business of the Aultman & Taylor Machinery Company, of Mansfield, Ohio, and the Stirling Company, of Barberton, Ohio. The resultant concern is the Stirling-Cahall Boiler Company, which has a capital stock of $4,500,000.

The position of the new company will be unique in that it will be in a position to supply to the trade practically every type of water-tube boiler on the market, since in addition to manufacturing boilers of the Stirling and Cahall horizontal and vertical types, it is said it will shortly take up and place upon the market an improved water-tube boiler of the water-leg type.

Details of the organization have not, it is said, been worked out, but it may be safely assumed that the consolidation will be one of organizations as well as of plants.

An aggressive policy will be maintained in the export department through the foreign connections of the Stirling Company in their offices in Johannesburg, S. A. R.; Havana, Buenos Ayres, Yokohama, the Hawaiian Islands, etc., as well as through their stockholders in the Stirling Boiler Company, Limited, of Edinburgh, which is interested in the water-tube boiler business of Great Britain and the Continent.

The Stirling Company was organized in 1890, and in 1898 established its marine department, securing control of the United States patents on the Niclausse, Yarrow & Mosher boilers, and its growth has been little short of marvelous, its sales in eight years showing an increase of nearly 800%.

The history of the Cahall sales department of the Aultman & Taylor Machinery Company has been equally honorable and creditable and the new company will start with enviable prestige and with every facility for both manufacturing and selling. The general offices will be at 111 Broadway, New York.

TRADE CONDITIONS IN MEXICO AND SOUTH AMERICA.

BY OUR SPECIAL CORRESPONDENT.

The possibilities for the expansion of our export trade in Spanish-speaking countries, referring especially to electrical machinery and equipment, are greater than is generally supposed in the United States. But these possibilities are thoroughly well understood by competing export nations, who have also taken time by the forelock in endeavoring to obtain a firm foothold in the Latin-American republics as a basis for future as well as present developments.

It cannot be denied that Germany and England are outstripping us in the matter of furnishing electrical supplies, among other commodities, to these countries. Under present conditions, the fact that our goods when put to the test place those other nations at a disadvantage evidently cuts no figure in the final result. If we lack that important requisite of successful trading, adequate selling facilities with regard to men and methods, on which after all, much, if not all, depends, we are at a decided discount as an exporting nation. It is obvious, therefore, that we have to contend with other conditions than the quality of our manufactured products, and not until our efforts are on a parity, or modeled on lines similar to those of our competitors, can we hope to compete successfully.

It should be understood by our export manufacturing houses that however competent a home drummer may be, the tact and talent which brought success to his efforts in the United States or English speaking countries, is wasted in Mexico, Argentine or Chili. The salesman who visits the South and Central American republics should thoroughly understand the Spanish language, as well as the business methods of the country, together with a knowledge of native laws with regard to tariff and customs charges, among others, and in their special bearing upon his mission. It is useless to depend upon the aid of the American Consul when one finds himself confronted with vexatious and perplexing matters which are of hourly occurrence due to the lackadaisical business methods common in the countries south of us. The writer has met American salesmen in Spanish-American countries, representative of large houses, finding themselves handicapped by untoward and unexpected conditions, with probably an imperfect knowledge of Spanish, together with inability to comprehend the apparently inexplicable trading system which prevails, so widely different from those to which he was accustomed at home, that in despair they would throw up their hands and long for the return trip. In the meantime it may be observed that the German commercial agent, trained to the situation even before his advent to the country and supported by his Consul or the legation itself, quietly and uninterruptedly proceeds in securing orders from the natives right and left. The position of the German agent is, therefore, that of a formidable, if not unassailable, competitor.

There is one thing, however, which can

be said in favor of our trade with Central and South American nations: The greater our investments, whether in mining, railroading or in agricultural lines, in like proportion will our export trade increase. The investment of American capital has, of course, the natural result, inasmuch as orders for machinery and other equipment are secured to American manufacturers. Our European competitors are, however, alive to this situation also, as evidenced by a report in the Dusseldorf Chamber of Commerce publication, which is to the following effect: "As yet, land can be purchased at low prices," referring to Latin-America, "but if the opportunity is not seized the United States capitalists will purchase out all, which will secure to them orders for machinery of every description to the detriment of German export interests."

Regarding electrical developments in Cuba, it is safe to assume that the bulk, if not all, of the supplies needed will be purchased either direct from the United States or branch American houses in Havana. Apart from the feeling of good-will displayed by the average Cuban toward America and things American, the United States has an advantage over other nations through the preferential rate tariffs accorded it by the Cuban Government. Owing to this fact a number of German manufactured products cannot be exported to Cuba unless at a loss.

If we were to estimate the ratio of progress in electrical developments in Cuba for the next four years, taking as a basis that of the past four years, the result would be surprising indeed. Electric power plants and central stations will cover Cuba from north to south within the next decade. An enormous amount of money is going into Cuba at this time, American investments already amounting to more than one hundred and fifty million dollars.

The Mexican Government has recently issued a pamphlet entitled; "Yesterday and To-day with Mexico." The pamphlet is of more than passing interest to American exporters in electrical lines particularly. Attention is called to the marvelous development of the resources of that country now proceeding, together with a forecast of the equally surprising possibilities. It is obvious to any one who has resided some time in Mexico that outside that country only a few persons have even an approximate knowledge of the gigantic efforts which she has made to place herself, within the space of a few years only, in the high position which she occupies among the Spanish-American republics. The pamphlet further shows the rapidity with which Mexico's foreign trade is increasing; in the one aspect only of its relations with the United States, the import and export, which in 1875 amounted to $11,000,000, has in 1904, reached $90,000,000, this amount being about equally divided between imports and exports.

The Argentine Republic is following closely on the heels of Mexico, but latest advices from that country are to the effect that the duties on imported manufactured goods will be increased in the near future.

Notes.

Late advices from Mexico are as follows: Pedro Alvarado, the multi-millionaire mine owner, has awarded to Weisel & Kock, of Parral, Chihuahua, the contract for installing a new electric power plant at his Palmullio mines. Boilers are to be of the high-pressure variety; engine, of the standard Corliss make, compound-tandem, with direct-connected 700-kw. alternating-current generators, 2200 volts and exciter. Weisel & Kock are in the market for electrical supplies, such as their contract requirements call for, and it is worthy of note that the Mr. Alvarado, who has placed the contract, is the same who volunteered to the Mexican Government to pay off the entire national debt.

The State of Vera Cruz has granted to Alfredo Kennion a concession for the construction of a suburban railroad system connecting the several towns in the neighborhood of Orizaba with the latter, the question of generating electrical power from the neighboring waterfall, which is of immense volume, being under consideration.

A concession will be granted by the State Government of Jalisco to Carlos Romero, of Hostotipaquilla, Jalisco, to construct an electric railroad to Etazatlan.

Colonel W. C. Green, the copper king of Cananea, Sonora, has organized a $15,000,000 stock company, part of whose plans is to build and operate a paper mill, the motive power to be electric.

The Peregrina Mining Company, operating in Guanajuato, recently purchased forty stamp mills from the Fulton Iron Works. They intend to erect a cyanide plant with a capacity of 250 tons, to be operated by electric power.

Work is being pushed on the electric power plant of the Black Mountain Mine Company, near Magdalena, Sonora. The plant will operate a stamp mill 35 miles off, and it is expected to be in operation by January of next year.

Colonel Daniel W. Burns, political boss of California and sole owner of the Candalaria mines in the San Damas district of the State of Durango, is having plans prepared for a hydro-electric plant. A mighty waterfall will be harnessed and the electric power will be sufficient to operate a number of mines, as well as a reduction plant in that neighborhood.

George G. Bergman, of the City of Mexico, has applied for concession to develop water power and build an electric plant on the River Blanco, Corooba Canton, Vera Cruz.

Vicente Martinez, of the City of Mexico, will build an electric plant for the transmission of electric power at Xicotlacotia between the States of Morelos and Guerrero.

La Electra Company, of Guadalajara, Jalisco, has authorized an issue of $2,000,000 of mortgage bonds for financing the construction of an electric street railway system in that city.

I. W. Conger, of Mexico City, brother of the United States ambassador, will construct an electric power plant in Chihuahua for the purpose of operating a street railway in that city.

The Mexican-American Power Company, recently organized and composed of Philadelphia capitalists, is about to undertake the largest electrical project over previously contemplated in Mexico. The amount of capital to be invested is $10,000,000, and of this sum $1,500,000 has already been subscribed. The project consists in erecting a series of electric power plants, three of them, it is understood, to be of sufficient capacity to generate 90,000 horse-power. Joel H. De Victor and A. S. Harvey, both of Philadelphia, are president and vice-president, respectively, of the company.

It should be noted that many articles of American manufacture are affected by the increase of import duties made by the Mexican Government, and which became effective the first of the present month. The duties are based upon the weight per kilo of 2½ pounds. The gross kilo includes the entire packing or casing, and the legal kilo is that prescribed in the traffic act. The rating on electric lamps per gross kilo is 11 cents, and on arcs per gross, 6 cents.

OBITUARY.

MR. EDWIN R. WHITNEY, the well-known engineer, died at the Margaret Pillsbury Hospital, Concord, N. H., on September 1. Mr. Whitney was head of the Whitney Electrical Instrument Company. He was the inventor and patentee of a voltmeter and a number of other instruments for the measurement of electrical currents. He was also interested in the development of the Shawinigan Falls Water Power Company, of Canada.

PERSONAL.

MR. R. F. HAYWARD, chief electrical engineer of the Utah Light & Power Company, has been appointed manager of the Mexican Light & Power Company, Mexico City, Mexico.

MR. E. A. REGESTINE has resigned as instructor in electrical engineering at Lehigh University, and accepted a position in the general sales department of the Standard Underground Cable Company, at Pittsburg, Pa.

MESSRS. DAVID PEPPER, JR., AND ALBERT REGISTER announce that the firm of Pepper & Register, engineers and general contractors, has been dissolved and succeeded by A. L. Register & Co.

MR. J. B. COWEN, formerly connected with the General Incandescent Arc Light Company, has been appointed manager of the sales department of the General Storage Battery Company, of New York City.

MR. B. H. WARREN, who retired from the presidency of the Allis-Chalmers Company on September 1, will, it is said, become the head of a new engineering and contracting company which is to be established in New York and which has several powerful interests associated with it.

MR. H. F. STRATTON, who has been connected with the principal office of the Electric Controller & Supply Company at Cleveland, Ohio, has accepted the position of New York representative of that company, with offices at 136 Liberty Street.

MR. CHARLES GARLAND has resigned as secretary of The Westinghouse Machine Company and accepted the vice-presidency and treasurership of the Pittsburg Fire-Proofing Company. Mr. Garland has been connected with The Westinghouse Machine Company for over twenty-one years and carries with him the best wishes of his former colleagues in his new field of activity.

MR. JAMES C. HAIN has resigned as engineer of masonry for the Chicago, Milwaukee & St. Paul Railroad and is now associated with J. G. White & Co., as superintendent of masonry construction, with headquarters at 43 Exchange Place, New York.

MR. RANDOLPH STRICKLAND, who for the past year has been assistant engineer in the Maintenance of Way department of the New York Central Railroad, has resigned from that position and joined the staff of J. G. White & Co., as assistant to the secretary. Mr. Strickland is a graduate of the Massachusetts Institute of Technology.

MR. W. G. CARLTON, formerly connected with the Chicago Edison Company, has been appointed superintendent of power of the electrical zone of the New York Central & Hudson River R. R. Company. Mr. Carlton will have charge of the two main electric power stations which the company is building near New York, the eight sub-stations and the transmission system. Mr. Carlton is a graduate of Cornell University.

MR. PUTNAM A. BATES has taken over the engineering busines of Bates & Neilson, from which Mr. John Neilson, who has been in poor health for the past six months, has retired. Mr. Bates gives special attention to the preparation of plans and specifications, supervision of electrical installations, special investigations and reports, and the application of electric power to machinery. He will continue the business at the old address, 42 Broadway.

MR. EUGENE HOLCOMB has been appointed manager of the newly created Foreign Department of the Allis-Chalmers Co., which includes supervision of all the foreign agencies and foreign selling representatives of the company. Mr. Holcomb is thoroughly familiar with engineering possibilities and projects in South America, having spent a number of years there. His headquarters will be at the general offices of the company at Milwaukee, Wis.

MR. M. A. PEARSON, of the Farrell Foundry & Machine Company; S. J. Gilpin and Thomas Waters, both of the Birmingham Iron Foundry; C. E. Miller, formerly of the Diamond Rubber Company; and William Spire, formerly of the Chase Machine Company, have joined the staff of the Aiton Machine Company and will devote their time exclusively to the rubber mill department of the company. Their headquarters will be at 126 Liberty Street, New York.

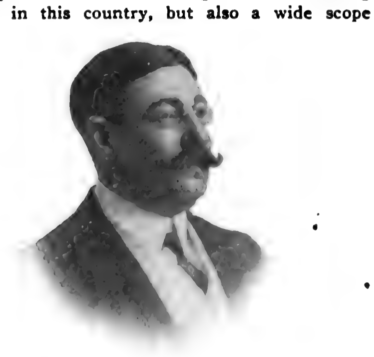
MR. WALTER H. WHITESIDE has been recently elected president of the Allis-Chalmers Co., succeeding Mr. B. H. Warren, whose retirement is noted elsewhere in this column. Mr. Whiteside joined the Allis-Chalmers forces in July, 1904, when he accepted the position of general manager of sales. At that time the company had just taken over the Bullock Electric Manufacturing

W. H. WHITESIDE.

Company and needed the injection of a vigorous and energetic personality into its sales forces. His promotion to the presidency indicates with what success Mr. Whiteside has met in his efforts. In his more responsible position, Mr. Whiteside has behind him the confidence of his organization, as well as a long and varied business experience, during which he has filled many executive positions. His achievements have won him recognition as a man of marked administrative ability. Mr. Whiteside is a member of the American Institute of Electrical Engineers, of the Engineers' and Lawyers' Clubs, of New York, of the Mid-Day Club, Chicago, and of the Milwaukee Club.

MR. H. F. J. PORTER, formerly manager of the American branch of the Westinghouse Companies' Publishing Department and afterwards second vice-president and general manager of the Nernst Lamp Company, has opened an office at 1 Madison Avenue, New York, as a consulting industrial engineer. Mr. Porter will devote his time to consulting industrial engineering practice, installing modern methods of organization and management leading towards industrial betterment, and welfare work.

MR. W. S. DORAN, formerly associated with the British Westinghouse Manufacturing Company, Ltd., has been appointed manager of the power department of the Allis-Chalmers Co. Mr. Doran will have full charge of the company's commercial affairs pertaining to reciprocating steam engines, steam and hydraulic turbines, condensers, gas engines, blowing engines for iron and steel blast furnace service, and rolling mill engines. Mr. Doran is well qualified to carry on this important work, having not only acquired knowledge in some of the largest manufacturing concerns in this country, but also a wide scope



W. S. DORAN.

of technical training through many years spent abroad. Mr. Doran has been connected with such concerns as the Southwalk Foundry & Machine Company, United Gas Improvement Company, Henry R. Worthington, and with the Westinghouse interests. He was tendered a banquet on the eve of his departure from England, which was attended by many well-known railway officials, manufacturers, electrical engineers, and representatives of practically all the large electrical manufacturing concerns in England.

TRADE PUBLICATIONS.

TESTING METER. General Electric Company.—Bulletin No. 4420, illustrating and describing the type I. B. Thomson high-torque induction test meter.

RAILWAY MOTOR. Westinghouse Electric & Manufacturing Company.—Circular No. 1120, in which is described the company's 113 railway motor for direct-current service.

TELEPHONE SWITCHBOARDS. The Dean Electric Company, Elyria, Ohio.—Folder No. 8, describing the No. 2 type of common-battery switchboards manufactured by this company.

TESTING INSTRUMENT. Queen & Co., Inc., Philadelphia, Pa.—Circular No. 605, devoted to new testing instruments for measuring resistance.

OIL ENGINES. De La Vergne Machine Company, New York.—A handsomely executed catalogue of standard size, describing the Hornsby-Akroyd oil engine, the American license for which is owned by the De La Vergne Machine Company.

STORAGE BATTERIES. National Battery Company, Buffalo, N. Y.—Bulletin No. 2, describing the installation of "unit accumulators" for the Syracuse & Suburban Railway Company, Syracuse, N. Y.

CONTINUOUS OILING SYSTEMS. Pittsburgh Gage Supply Company.—A well-executed catalogue describing the White Star continuous oiling system made by this company, together with methods of installation.

MINIATURE LAMPS. The Federal Miniature Lamp Company, New York.—A well-executed catalogue of standard size, illustrating every type and style of incandescent lamp in general use, with or without bases, of less than one inch in diameter.

VALVE SPECIALTIES. Golden-Anderson Valve Specialty Company, Pittsburg, Pa.—Pamphlet No. 4, entitled "Worth Has Won," and describing the various valves made by this company, many of which have been illustrated and described in the columns of this paper.

CALENDAR. The Bryant Electric Company and the Perkins Electric Switch Manufacturing Company, Bridgeport, Conn.—A card the upper half of which shows a picture of the factories of the companies mentioned, and the lower half containing a calendar pad from September, 1905, to December, 1906, inclusive.

BELT-DRIVEN GENERATORS. National Electric Company, Milwaukee, Wis.—Bulletin No. 355, devoted to a description of the type MB, direct-current generators manufactured by this company. These are built in capacities of 50 to 800 kilowatts, with speeds and voltages to suit requirements.

MAGNETO SIGNALLING APPARATUS. The Holtzer-Cabot Electric Company, Boston, Mass.—Bulletin No. 200, containing a description of bridging and series magneto bells, central energy sets, hand generators, extension bells, toll line indicators, circuit closers, ringers, magneto generators, gravity hooks, etc.

VOLTMETER AND FREQUENCY INDICATOR. Wagner Electric Manufacturing Company, St. Louis, Mo.—Bulletin No. 73, describing a combined voltmeter and frequency indicator brought out by the Wagner Company. The instrument is built for any voltage and frequency and is provided with two scales, one reading "volts" and the other "cycles."

DIFFUSER CEILINGS. American Metal Stamping Company, Inc., Philadelphia, Pa.—Bulletin A-21, devoted to the light balancing selective diffuser ceilings. These ceiling are made of steel with impressed designs on the surface to give an excellent diffusion of light. The bulletin also contains a treatise on the subject of color and distribution of artificial lights.

WIRELESS CLUSTERS. Benjamin Electric Manufacturing Company, Chicago, Ill.—A 64-page catalogue, in which is listed a number of new specialties and improved forms of wireless clusters. The catalogue is accompanied by an eight-page folder illustrating the ceiling, fixture, suspension and out-door forms of the "arc-burst" cluster.

STRANDING MACHINE. Aiton Machine Company, New York.—Bulletin No. 62, describing the company's 18-drum stranding machine. The drums are carried in steel cradles which are connected by cranks to an eccentric ring for keeping torsion out of the wires. The machine is driven from the front and can be used as a separate unit or in tandem with others. Cut gears are used throughout. The die holder is adjustable in each direction and is adapted for split dies.

BUSINESS NEWS.

COMMERCIAL ELECTRIC SUPPLY COMPANY has recently moved to new headquarters at the northwest corner of Fifteenth and Pine Streets, St. Louis, Mo.

THE AMERICAN ARC LAMP COMPANY, successor to the Lea Electric Manufacturing Company, of Elwood, Ind., is now located at Kalamazoo, Mich., in new and larger quarters.

PEPPER & BOWIE have opened an office in the Land Title & Trust Building, Philadelphia, as engineers and general contractors. The firm will specialize in electric roads, water-power plants, general contracts and reports and estimates.

THE RELIANCE ENGINEERING COMPANY has opened offices at 701 Traction Building, Cincinnati, Ohio, for consulting and contracting engineering work. Mr. Laurent Lowenberg is the electrical engineer.

ELECTRIC APPLIANCE COMPANY, of Chicago, states that owing to the convenience of its new and well-filled store-rooms it is able to keep pace with demands, for electric lamps, all orders being promptly filled from Chicago stock on the day of their receipt.

BOSTON INCANDESCENT LAMP COMPANY, Danvers, Mass., reports that it supplied all the incandescent lamps used at Steeplechase Island, a popular resort at Bridgeport, Conn. Seventy-five thousand lights were connected for illuminating purposes.

CHARLES R. UNDERHILL, New York City, has recently issued a sheet, with 35 illustrations, showing the various types of alternating and direct-current electromagnets. A pamphlet, entitled "Facts About Electromagnets," accompanies this sheet, both of which may be had on request at his office, at 55 Liberty Street, New York City.

GEORGE W. LORD CO., Philadelphia, states that with the cessation of hostilities in the far East they have again resumed the shipment of Lord boiler compounds to Japan and Russia. In addition to filling standing orders, a cable order was recently received from Vladivostock for a carload of compound to be shipped via Seattle, Wash.

STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., reports having closed contracts for switchboards for the following places: Mt. Pleasant, Ill.; Hunter, N. D.; Union, Miss.; Harris, Pa.; Des Moines, Ia.; Roann, Ind.; Tower Hill, Ill.; Milacca, Princeton; Foley, North Branch, Rush City, Mora, Forest Lake, Grandy, Lindstrom, Braham, Minn.; Olathe, Kan.; Rochester, N. Y.; Truro, Ia., and Kalama, Wash.

MACHADO & ROLLER, of New York City, have recently opened a branch office in the Monadnock Block, Chicago, where it is intended to carry a varied assortment of standard Whitney instruments, so that prompt deliveries may be made to the local trade. Secondary standards for purposes of comparison are kept constantly on hand, and facilities for making simple repairs in Chicago are also provided. The office is in charge of Mr. H. I. Shire, formerly of New York.

THE EUREKA ELECTRIC LAMP COMPANY, of Cleveland, Ohio, and the St. Marys Incandescent Lamp Company, St. Marys, Pa., have been consolidated under the name of the St. Marys Incandescent Lamp Company, with a capital stock of $100,000. The company proposes to engage in the independent manufacture of incandescent electric lamps, and for that purpose is erecting a new factory at St. Marys, Pa., which is to be equipped with the latest and most improved machinery.

COPLEY-SENIOR CARBON COMPANY, New York, have perfected a brush which is claimed to be thoroughly self-lubricating, noiseless, non-sparking, non-cutting, and uniform throughout; retaining these qualities until entirely worn out. The carrying capacity of the brush is said to be very good. Mr. George W. Copley is president and general manager; Mr. George W. Enos, vice-president, and Mr. John L. Senior, secretary and treasurer of the company, whose office is at 465 Greenwich Street, New York City.

J. G. WHITE & CO., New York, are building for the Waltham Gas Light Company, of Waltham, Mass., a power house of re-enforced concrete. Steam will be supplied by four 350-h.p. Sterling boilers, an 8½x180-ft. re-enforced concrete stack furnishing natural draft. Suspended coal bunkers will occupy the upper half of the boiler-room; these will be filled by coal conveyors, and chutes operated by valves from the boiler-room floor will convey the coal to the boilers. Two 500-kw. Westinghouse-Parsons turbo-generators form the main generating equipment.

B. F. STURTEVANT CO., Boston, Mass., has supplied through its engineers, Sanderson & Porter, New York City, to the New Orleans (La.) Railway Company six large economizers which are unique in that they are built to withstand the highest pressure to which an economizer is known to have been subjected. The pipes are tested to 600 pounds pressure before they leave the works, and each section is tested to 500 pounds after the pipes are inserted. There is but a single gasket joint running through the machine, this joint being made of two heavy flanges on a special gasket which has 2¾ in. plain surface through the entire circle. The company has also supplied the Wilkesbarre (Pa.) Gas & Electric Company with a forced-draft apparatus feeding six 225-h.p. boilers.

THE WESTINGHOUSE MACHINE COMPANY reports that during the past month orders have been received for no less than fifty-one Roney mechanical stokers ranging in size from 54 in. x 20 grate to 132 in. x 26 grate, the largest of the orders being that of the Pennsylvania Railroad for six 132 in. x 26 grate stokers and five 100 in. x 20 grate stokers. A large order from the Ohio Hospital for Epileptics, at Gallipolis, Ohio, has also been received, and others from the American Bridge Company, Ambridge, Pa.; National Tube Company, Pittsburg, Pa.; Detroit United Railway Company, Detroit, Mich.; York Engineering Company, York, Pa.; Proctor & Gamble Co., Cincinnati, Ohio; The Union Rolling Company, Cleveland, Ohio; Gulfport and Mississippi Coast Traction Company, Gulfport, Miss.; United Presbyterian Board of Publication, Pittsburg, Pa.; Indiana Boys' School, Plainfield, Ind.; B. & O. Office Building at New York City, and the Railway Exchange Building at Chicago, Ill.

THE ABNER DOBLE COMPANY, of San Francisco, has recently received several interesting orders for Doble tangential water wheels. Prominent among them is an order from the California Gas & Electric Corporation for a 9000-h.p. wheel for its De Sabla power plant. The wheel will operate under a head of 1530 feet at 400 r.p.m. and will be driven by a single jet of water, thus making it the most powerful water wheel ever constructed for operation under a single jet of water. Another order from the California Gas & Electric Corporation calls for six 570-h.p. wheels for its Nevada City plant. Those will operate under a 190-foot head at 410 r.p.m. A 400-h.p. Doble wheel for operation under a 400-foot head, equipped with jet deflector operated by a Woodward compensating governor, has been shipped to the Chancellor Gold Mining Company, Wenatchee, Wash. The La Grande Water Storage Company, La Grande, Ore., has purchased an 800-h.p., 1150-ft. head, 600 r.p.m. Doble wheel, equipped with Doble needle regulating nozzle for operation by a Lombard governor. Among other recent orders secured by the company are two double 1750-h.p. wheels for the San Joaquin Power Company, Fresno, Cal., for operation under 385-ft. head; one Doble needle regulating nozzle for a large water-wheel for the Komata Reefs Gold Mining Company, New Zealand, and a double 700-h.p. water wheel unit for Mitsui & Co., Japan, for operation under 210-ft. head, this order including the wheel complete with Lombard governor and gate valve. The University of Michigan has purchased the Doble tangential water wheel which the Abner Doble Co. exhibited at the St. Louis World's Fair and for which the company was awarded the grand prize. This wheel is to be installed in the hydraulic laboratory of the new Engineering Building at Ann Arbor, Mich., where it will be mounted in connection with a Duplex pump for experimental purposes, its output being 100 horse-power when operating under a head of 580 ft. The 12-in. laboratory water motors which the Abner Doble Co. builds for technical schools and universities have attracted considerable attention among the engineering faculties of many of the leading educational institutions, and the interest shown in these small water wheels has resulted in an increasing demand for them, orders having recently been received from the University of Wisconsin, the Michigan School of Mines and the University of Toronto.

CENTRAL STATION NEWS

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

ALABAMA.

ALBERTVILLE.—A number of the business men of Albertville have organized a company to be known as the North Alabama Railway, Light & Power Company, with a capital of $100,000. The purpose of the company is to connect all Sand mountain towns with an electric railway, provide water works for the larger towns and to light the towns with electricity. J. G. Elrod, president; N. A. Elrod, vice-president and business manager, and W. M. Coleman, secretary.

CARBON HILL.—Bids have been called for a water and light plant, work to include erecting a brick or concrete block power house, furnishing a 100-h.p., high-speed automatic engine; two 100-h.p. boilers and fittings, furnishing one compound, one duplex and one feed pump; furnishing and erecting an 80,000-gal. steel tank and tower; constructing an 80,000-gal. surface reservoir, and furnishing a 60-k.w., 60-cycle, single-phase, 2300-volt alternator, together with exciter, switchboard and station instruments; pole line, transformers and twenty standard 6.6-ampere, series inclosed arc lamps of latest design.

ARIZONA.

ROOSEVELT.—Bids will be received until November 1 by O. H. Ensign, Electrical Engr. U. S. Reclamation Service, Los Angeles, for furnishing complete f. o. b. bidders' works, one or more alternating-current, 900-k.w., 25-cycle generators, one or more 100-k.w., direct-current generators for exciter, and a switchboard containing one panel for generator and one panel for exciter, for use in Roosevelt power house, Salt River Project, Ariz.

CALIFORNIA.

LOS ANGELES.—The Yuma Electric & Water Company is reported incorporated, with a capital of $100,000, by A. A. Talmage and others.

BEN LAMOND.—The Ben Lamond Light Company will extend its service to Felton, three miles distant, and the line is under course of construction.

AVALON.—The Santa Catalina Island Company is arranging to increase the capacity of its plant, by installing larger direct-connected engines.

ANAHEIM.—C. A. Copeland, of Los Angeles, is stated to have estimated the cost of the proposed improvements to the electric light plant at $22,000 and to the water works at $18,250.

GILROY.—Bids are being considered by the Mayor and Common Council for $11,000 bonds for electric light and power works and an electric lighting system. C. N. Hoover is city clerk.

OROVILLE.—The Oroville Water, Light & Power Company has issued specifications calling for the equipment of its new water power electric transmission plant. Two 750-kw., three-phase generators 2000 to 2300 volts, with alternative of two 1000-kw. generators are included. There will also be required raising and lowering transformers, switchboard and sub-station equipment. Cory, Meredith & Allen are the engineers.

RIALTO.—A. L. Selig, manager of the Edison Electric Company, it is reported, has made a proposition to the citizens of Rialto to extend a wire for 10,000 volts from San Bernardino, the Rialto citizens to establish their own local operating company, furnish wires, meters, transformers, etc.

SAN LUIS OBISPO.—B. F. Thomas, manager of the San Luis Obispo Gas & Electric Company, states that the C. C. Moore Company, of San Francisco, has secured the contract for constructing a new plant of 270-kw. capacity. A. M. Hunt, of 614 Mission St., San Francisco, is the engineer.

SAN BERNARDINO.—The Little Creek Power Company, it is reported, has engaged F. A. Worthely, superintendent of the Riverside electric light plant, to prepare plans and specifications for its steam plant and distributing system in this city. It is reported that bids are soon to be asked.

YREKA.—The Siskiyou Electric Power Company has awarded a contract to the Pelton Water Wheel Company for a 2000-h.p. water wheel for direct connection to a 1000-kw. engine-type generator running at 360 r.p.m., the effective head being 700 feet. This is a duplicate of the wheel installed a couple of years ago.

LOS ANGELES.—The Council has adopted a report of the Lighting Committee, it is stated, in which it is recommended that the City Clerk ask bids for municipal lighting under the following terms: one year contract, not to exceed 2000 lights, three-year contract not to exceed 2500 lights and five-year contract not to exceed 3000 lights.

FERNDALE.—An ordinance has been adopted by the Board of Supervisors, granting to the Ferndale Electric Light Company (W. W. Barnes, secretary, Ferndale), a franchise to construct poles, wires and other conductors for electric purposes along the road in First Supervisorial District, of Humboldt County. W. H. Haw, County Clerk.

POMONA.—It is reported that the farmers and orange growers in the vicinity of Pomona are organizing a company to build an electric power plant with which to furnish power for all pumping plants in the vicinity and operate a belt trolley line, connecting all the near-by towns and ranches, including Chino, Ontario, Claremont, North Pomona, Lordsburg, San Dimas and Covina.

SAN FRANCISCO.—The Eel River Power & Irrigation Company is building the pole line on its 22-mile transmission from Potter Valley to Ukiah. It is probable that a transmission line will be built to San Francisco, a distance of 130 miles, as the market for power near the plant is limited. The machinery ordered includes two 2000-kw., three-phase generators and two Victor turbine water wheels.

STANISLAUS.—The Stanislaus Water & Power Company, for which Sanderson & Porter acted as engineers, is doing preliminary work under the direction of Beach Thompson, the promoter. It is proposed to build dams for catching up all the water of the Stanislaus River and conveying it by means of ditches, flumes, etc., to Sulbets Flats to a point where a drop of 1500 feet can be had, and where the power plant is to be installed.

SAN FRANCISCO.—The California Gas & Electric Company has completed the installation of two additional 5000-kw., three-phase generating units at its Electra power station. This addition to the three generators already in operation gives the Standard Electric transmission line a large capacity. The company will also install two additional 1000-kw. polyphase generators on the South Yuba transmission system, which was acquired from the Van Nordens. There is an unlimited amount of water available for further development on the South Yuba.

SAN FRANCISCO.—It is reported that the Tuolumne Electric Company, which is constructing a water-power electric plant near Tuolumne, Cal., has arranged to sell power to operate the projected Kemp, Van Ee electric road from Santa Cruz to Hollister and to the new cement works to be erected in the San Juan Valley. H. Hersey is president and C. W. Quilty manager of the electric power company. The machinery contracted for includes two 600-kw. Bullock, three-phase generators and a 1200-h.p. Platt Iron Works wheel operating under 425-foot head.

FRESNO.—A deed has been filed with the recorder transferring the property of the San Joaquin Power Company to the San Joaquin Light & Power Company, to enable work to be done with a larger capital than possible under the old company, which was incorporated for $800,000. The new corporation has a capital of $3,000,000. It is understood that no outside capital has been taken in, the expansion being from within. The action was necessary to cover the plans in contemplation for the development of more than 50,000 horsepower for use in the valley.

COLORADO.

LAKE CITY.—The Hinsdale Electric Light & Power Company is making several changes in its plant and equipment, the most important of which is the establishment of a day circuit. New machinery is being installed to provide for the additional service.

CONNECTICUT.

NORWICH.—The Uncas Power Company, has been incorporated with a capital of $1,000,000.

NORWALK.—It is stated that the Mayor is to appoint a committee of three to investigate the cost of installing a municipal lighting plant.

STERLING.—The Sterling Power Company has been incorporated with a capital of $500,000, and will distribute electric light and power to the towns of Sterling, Plainfield, Brooklyn and Killingly.

NEW HARTFORD.—The Northern Connecticut Power Company, of New Hartford, has been incorporated to operate in Litchfield, Hartford and Tolland Counties under certain restrictions, and is to develop water power on the Farmington River.

PACKERSVILLE.—Negotiations are now in progress for the purchase of the Packer power privilege here in behalf, it is understood, of the New York, New Haven & Hartford Railroad, which wishes to erect an electric power station for the eastern Connecticut branch of the Consolidated Railway Company and to furnish lighting for Wauregan, Moosup, Plainfield and other nearby towns.

RIDGEFIELD.—There is every prospect that Ridgefield will have a new electric plant in the immediate future. A meeting of the stockholders of the Ridgefield Electric Company has been held, at which the following directors of the company were elected: Henry E. Anderson, John A. Mitchell, George Pratt Ingersoll, George G. Haven, Jr., Dr. R. W. Lowe, Albert H. Wiggins; secretary, Harvey P. Bissell. Mr. Kirk has been made general superintendent and assistant secretary of the Electric Company.

KENSINGTON. — The directors of the Kensington Water Power Company, of Kensington, have voted to dissolve the corporation and to wind up its affairs. A final dividend of $1,729 has been declared and distributed among the stockholders. The company was organized in 1890 to secure control of the water privileges which were then held by the Anglo-American Electric Company. Recently the Kensington company sold the privileges and rights to the American Paper Goods Company, which had previously operated them under lease. The water company has been financially successful.

NEW MILFORD.—The Connecticut Railway & Lighting Company has acquired ownership of the New Milford Water Power Company. The property was organized in 1893, and had outstanding capital of $1,000,000, and bonds amounting to $1,000,000. The concern built a large plant near New Milford and drained the Housatonic River near Bull's Bridge and other places to supply power. It had a 30-year contract to supply power to the Connecticut Railway & Lighting Company at $130,000 a year. The power is used to operate trolleys near Waterbury and other places. The bonds of the New Milford Water Power Company are now guaranteed by the purchasers. The officers in the New Milford Water Power Company are: Winthrop Bushnell, president; Louis E. Stoddard, vice-president, and Samuel G. Morehouse, secretary and treasurer, all of New Haven. The company's Waterbury station was described in the June number of this paper.

FLORIDA.

QUINCY.—The citizens are reported to have voted to issue $5000 bonds for improving the water works and electric light plant.

ST. PETERSBURG.—The St. Petersburg Investment Company, which owns the electric light plant and street railway, contemplates moving the plant and reconstructing it with the addition of a 350-h.p. boiler and two 250-h.p. engines.

JACKSONVILLE.—Bids will be received until October 4 by the trustees of the water works and improvement bonds for furnishing and setting in place on foundation furnished by the board at the electric light station two 500-k.w. steam turbo-generators, a steam-driven exciter set and switch panels; turbines to be run condensing, steam pressure at boilers 150 lbs., no superheat, 27 in. of vacuum; generators to be of the revolving-field type, three-phase, 60 cycles 2,300 volts. Blue prints and specifications are to be furnished with bids. Mr. R. N. Ellis is the superintendent.

GEORGIA.

SAVANNAH.—The City Council has passed the ordinance granting a franchise to the Savannah Lighting Company.

JACKSON.—The citizens are reported to have voted September 5 to issue $40,000 bonds for water works and an electric light plant.

ATLANTA. — The Southern States Electric Company has been incorporated with a capital of $20,000 by Joe W. Little and Charles M. Coyen.

WASHINGTON.—Capt. J. H. Fitzpatrick, of Washington, is reported to have purchased the Anthony Shoals property in this county, and will develop this power on the line between Wilkes and Elbert counties and transmit same to Washington, Elberton and Anderson, S. C., and build a railroad from Washington to Elberton.

HAWAII.

HONOLULU.—The plant recently furnished the Hawaiian Electric Company on the Island of Kauai, is about ready to be installed. This consists of a double Pelton unit of the overhung type, operating under a head of 550 feet and direct-connected to a 1,200-kw. generator running at 375 r.p.m., the water wheel having a maximum capacity of 2,500 horse power. Power is transmitted electrically a considerable distance, and is used in connection with pumping for irrigation, which is attracting much attention of late.

IDAHO.

TETON.—The Fremont Light & Power Company has been incorporated, with a capital stock of $25,000.

WEISER. — The Swan Falls Light & Power Company is reported to have petitioned for a franchise to light the city.

SANDPOINT. — The Sandpoint Electric Company is reported to have sold its plant to the Pend d'Oreille Electric Company, having a capital of $50,000.

BOISE. — The Boise-Payette Electric Power Company recently increased its equipment by the addition of another 500-kw. generator and turbine.

MOSCOW. — The Moscow Electric Light & Power Company, it is stated, contemplates extending its lines in the near future to Pullman and Palouse, Wash.

GRANGEVILLE. — The Grangeville Electric Light & Power Company is doubling its hydraulic electrical outfit in order to meet the increased demands for lighting and power service.

MOUNTAIN HOME.—The new $35,000 plant which Mr. Seymour J. Bell, of Sumpter, Ore., has been erecting here, is nearing completion, and it is expected that the town will be furnished with lights therefrom very shortly.

BLACKFOOT.—E. W. Wade, of Ogden, and Christian Just, of Blackfoot, are reported to be interested in the construction of a power plant on Blackfoot River, to supply Idaho Falls, Blackfoot and other cities with electric light and power; probable cost of plant, $100,000.

ILLINOIS.

PEKIN.—The Tremont electric light and power plant will be rebuilt.

MORRISON.—The Morrison Electric Lighting Company has increased its capital stock from $20,000 to $60,000.

BELLEVILLE.—The City Council has appointed engineers to prepare estimates of the proposed municipal electric lighting plant.

FREEBURG. — Charles Kessler, village clerk, states that the proposed municipal electric light plant will cost about $9,000. No engineer has been selected yet.

CUBA.—A new 150-h.p. engine, simple automatic, and a 100-kw., single-phase, 125-cycle alternator is to be installed in the municipal plant. L. Monch. superintendent.

SPRINGFIELD.—The City Council is reported to have authorized the Mayor to take over the properties and plant of the Springfield Electric Light & Power Company.

GLASFORD.—Reports state that steps are under way for the establishment of an electric light plant, but none of the particulars concerning the project are known as yet.

CHICAGO.—The Gillett Light Company has recently changed its title to that of the Standard Gillett Light Company and increased its capital stock from $5,000 to $30,000.

BLOOMINGTON.—A syndicate of Detroit capitalists, headed by Emanuel T. Beyer, has purchased the Union Gas Light & Electric Company for $400,000, the amount of the capital stock.

EUREKA.—W. J. Whetzel, it is stated, has secured the contract to light the city until June 1, 1906. The bid submitted was $2.50 per light per month until midnight and $3 per light per month until 1 A. M.

CHICAGO.—Bids will be received until November 1 by the Board of Trustees, Sanitary District of Chicago (S. D. Griffin, clerk), for constructing a canal lock, movable dams and a fender wall, in connection with the water power development now being made near Lockport.

VANDALIA.—The Vandalia Light & Fuel Company recently sold its electric light plant to the city of Vandalia for $18,000. A number of taxpayers have since filed suit to enjoin the consummation of the sale on the grounds that the city is already indebted beyond the constitutional limit and has no right to engage in the business of selling light.

INDIANA.

GENEVA.—The Town Council has granted W. R. Thurston a franchise for an electric light plant.

DANA.—F. R. Calvert has been awarded the contract for constructing the proposed electric light plant in this city.

JASONVILLE.—It is reported that the Jasonville Electric Company (James H. Parsons, president) will soon ask bids for constructing an electric light plant here.

CLINTON.—The Clinton Electric Light Company has purchased and will install two Westinghouse dynamos and one 150-h.p. Hamilton-Corliss engine. A new dynamo room is being built.

VAN BUREN.—The Huntington Light & Fuel Company (F. D. Townsend, superintendent) has petitioned the City Council for a franchise for the erection and operation of an electric light plant in this city.

VALPARAISO.—The Valparaiso Lighting Company has been incorporated, with a capital stock of $150,000. The directors are Clarence H. Geist, Charles B. Kelsey, H. W. Noble, Edward Clifford and D. S. Davis. This is a new company which recently bought the plant and property of the Valparaiso Light & Fuel Company for $60,000.

PERU.—A statement for the year ended June 30, 1905, has just been issued by the committee having in charge the municipal lighting plant at this place. The city maintains 130 lamps at an average cost of $26 per lamp per year. An expenditure of $30,000, the committee reports, is needed to put the plant in good condition.

INDIAN TERRITORY.

MUSCOGEE.—The plant of the Muscogee Electric Light & Power Company has been destroyed by fire, with a loss estimated at from $3,000 to $5,000.

PAUL'S VALLEY.—The St. Louis capitalists who have been in the city recently looking over the local electric light plant have purchased the plant, it is said, and will at once add a gas plant.

IOWA.

MARSHALLTOWN.—It is stated that the Council has authorized the water and light committee to make repairs to the lighting plant; two new dynamos are needed.

LE MARS.—The Gas & Electric Development Company, of Philadelphia and New York, reports the sale of the Le Mars plant. The property was purchased by Mr. Bascom Parker, of Niles, Mich., who assumed control September 1. Extensive improvements will be made.

KANSAS.

HERRINGTON.—Charles F. Custafson, of Topeka, it is stated, has secured a franchise to furnish water, electric light and power to Herrington.

ATCHISON.—The Atchison Railway, Light & Power Company has amended its charter, increasing its capital from $300,000 to $900,000, and will build interurban lines to surrounding towns.

WEIR CITY.—The Weir City Light & Power Company has made a contract to furnish the branch line of the Pittsburg Street Railway Company with power. This extension will go to Scammon and other points.

ELLSWORTH.—Mr. Paul Reaume, owner, and Mr. Clarence Pohlman, superintendent, of the People's Electric Light Plant, have plans under way for making the Ellsworth plant one of the most modern and up-to-date in the West.

PITTSBURG.—The C. A. Burton Machinery Company has been awarded the contract for installing an electric light and power plant for this city.

TOPEKA.—A new corporation, the Topeka Edison Company, has been granted a charter by the Kansas State Board. This is the company, backed by the backers of the City Railway Company, which has bought out the Edison Electric Illuminating Company. The capital stock is $1,250,000, divided up into 12,500 shares of $100 each. The directors are as follows: B. E. Sunny, L. E. Myers, E. E. Wilson, George B. Caldwell, George H. Taylor, Frank G. Kelly, Albert M. Patten, C. R. Maunsell, Albert H. Priddy. The last four are Topeka people. Three trustees are named who hold 5,480 shares of stock in trust, but are not in the directorate of the new company. They are E. A. Potter, Jr., Theodore P. Bailey and F. R. Fenton, all of Topeka. The new light company will put in a large power plant and furnish current to the railway company.

KENTUCKY.

SOMERSET.—W. G. Hunter, of Somerset, has received the franchise for an electric light plant.

ASHLAND.—The Virginia Light & Power Company is reported incorporated, with a capital of $25,000, to construct an electric lighting system from Richmond, Va., to Ashland.

CAMPBELLSVILLE. — J. L. Atkinson, president of the Campbellsville Lighting Company, writes that the construction of the proposed electric light plant will be under the supervision of E. S. Kincort, superintendent, who will probably expend $5,000.

MAINE.

PORTLAND. — The Citizens' Water & Light Company has been formed. Capital, $230,000. President, C. E. McGlauflin; treasurer, H. L. Cram. Directors, as above and A. F. Pine, all of Portland.

BANGOR.—The Stanley Electric Manufacturing Company, of Pittsfield, Mass., it is reported, has closed a contract with the Bodwell Water Power Company, of Bangor, for eight 1,000-kw. generators and necessary switchboards, the cost to be about $75,000.

BIDDEFORD. — The Pepperell Manufacturing Company is to install an electric light plant to light both the Pepperell and Laconia division by electricity, instead of by gas, as at present. The plant will be installed this fall and be in working order for the winter days.

AUGUSTA.—The Kennebec Light & Heat Company has recently purchased a new three-phase generator. The new machine will be used for the purpose of generating the power that is to be used at East Winthrop, and for the Tayntor Company, at Hallowell, and probably the State House will also be lighted from this machine.

MARYLAND.

HYATTSVILLE. — A committee has been appointed to report on the construction of a municipal electric light plant. Harry W. Shepherd, chairman light committee.

BALTIMORE.—The Consolidated Gas, Electric Light & Power Company has advertised in the local papers the fact that since the great fire it has doubled its business in 16-c.p. lamp equivalents, and has tripled its power service in horse-power of motors connected. Mr. D. Barnett, formerly of New York, is the energetic manager of the system. The contract for the company's new Westport power house, to cost $150,000, was recently awarded to the Baltimore Ferro-Concrete Company.

ELKRIDGE.—A delegation from the First, or Elkridge, district of Howard County has been before the county commissioners to protest against any change in the method of lighting the village of Elkridge. The delegation brought a numerously signed petition. About a month ago a five-year contract was awarded to the Patapsco Electric Lighting Company, of Grays, Baltimore County, calling for 1,800-c.p. lights, the wiring to be completed and service begun October 1. The system now in use, supplied by the United Electric Company of Baltimore, furnishes arc lights of 2,000 candle-power. The petition claims that the same amount of money is required for fewer lights under the new contract.

MASSACHUSETTS.

LAWRENCE.—At the regular monthly meeting of the water board Superintendent Collins was instructed to ascertain the cost of installing and maintaining an electric lighting plant at the pumping station and report at the next meeting.

UPTON.—The Upton Electric Company has sent a letter to the local authorities declining to accept the conditions whereby the use of Upton's streets could be secured for the carrying on of electric lighting service. The selectmen gave the company privileges of location, provided the company would light Upton Town Hall free of charge while the contract was in force.

WALTHAM.—A new power house is in process of construction at Waltham. The building will be of concrete and steel construction, 153 feet in length, 100 feet wide and 35 feet high, with a boiler room at the rear at a lower level. When the building is completed three generator engines, now being built, will be installed; power will be supplied for electric lighting and for the street car service.

HOLYOKE.—The contract for the new power plant of the Holyoke Water Power Company has been awarded to Casper Ranger for about $150,000. The contract includes the building, the canal walls of granite, head gates of iron, and it is estimated about 1,000,000 brick will be required in addition to the other material. The house will be located near the Norman paper mill, and the excavations have been made. Mr. Ranger has already begun construction work.

HOLYOKE.—Manager Snow, of the municipal gas and electric department, has given out the annual report of the department required by the State Lighting Commission. In spite of reductions in the price of gas and tar, the returns of the gas department show a profit, although it is about $19,000 less than last year. The electric department receipts show a profit of $14,767.02. While this report shows a working period of a year, yet it is not the annual report made to the Mayor. The profits of the department for the year were $18,485.52.

MICHIGAN.

GRAND RAPIDS.—The Grand Rapids Edison Company is preparing to install a steam turbine.

GRASS LAKE.—The lighting proposition has been carried in this city by twenty-three majority. Work will be commenced at once on the new plant.

ROSE CITY.—James Monaghan and Frank G. Bell have secured a franchise to install a commercial lighting plant, the contract for which has been awarded to the M. B. Wheeler Electric Company.

GRAND RAPIDS.—The Grand Rapids Electric Light Company has been incorporated, with a capital of $15,000. Incorporators: Walter C. Winchester, W. C. Miller and E. A. Stowe.

PONTIAC.—Engineers McKean, Ball & Co., of Chicago, Ill., write that the general contract for constructing the plant of the Clinton River Power Company has already been let, but wire and supplies and arc lamps are yet to be purchased.

FLORENCE.—A. E. Edmonds and Rhinelander capitalists, it is reported, will construct a power plant to supply the cities of Florence and Crystal Falls with light, and operate an interurban line from Iron Mountain to Spread Eagle Lake.

CHEBOYGAN.—Dr. A. M. Gerow is promoting an enterprise to dam Pigeon River. He has the necessary flowage rights. The entire cost of the investment will be $350,000, the current delivered in Cheboygan, the transformer station included. The plant is to generate 8,000 horse-power. The head will be 75 feet.

SAGINAW.—The Rifle River Power Company has filed its articles of association. The company is organized to produce electricity for lighting, heat and power. Its plant will be erected on Rifle River in Arenac and Ogemaw counties. The capital stock is $2,000,000, all subscribed, $2,000 paid in. The stockholders are George Silsby, Frank E. Kleinfeld, Alvah E. Kendall and Edwin Stapleton, all of Saginaw.

DELRAY.—The Solvay Process Company has lighted the village of Delray since its incorporation. Its contract expires next April, and unless some arrangement is made the village will have no lighting system. Delray is to be taken into Detroit, and the Edison Illuminating Company has secured a contract with the Solvay Company for illuminating when the contract which compels the latter company to light the village expires.

GRAND RAPIDS.—The Grand Rapids & Muskegon Water Electric Power Company, owning flowage rights on the Muskegon River and the biggest power dam in Western Michigan, located near Big Rapids, has entered Grand Rapids for the purpose of supplying light and power for commercial purposes. The Muskegon Company already has the contract for furnishing power to the Grand Rapids & Muskegon interurban, and it has been reported that the new deal involves the furnishing of power also to the Grand Rapids & Holland interurban.

MINNESOTA.

MOUNT IRON.—This village is reported to have voted to install an electric light plant.

MINNEAPOLIS.—It is stated that bids will probably soon be asked for furnishing the city 1,000 electric lights and 2,200 gasoline lamps.

MISSOURI.

WAUSAW. — The proposition to issue $6,000 electric light bonds was carried at the recent election.

ST. LOUIS.—The Natural Power Company of this city has increased its capital stock from $30,000 to $60,000.

OWENSVILLE.—Work has been commenced on the power plant to be erected here by Peter Helling, of Gerald.

FARMINGTON. — The Farmington Electric Light & Ice Company will probably add shortly to its equipment an additional unit for the purpose of supplying a day circuit and heating service.

ST. LOUIS.—The General Fuel & Illuminating Company, of St. Louis, has filed a statement showing that it has increased its capital stock from $60,000 to $70,000, all the increase paid.

ST. CHARLES.—The city electric light plant is receiving a complete overhauling. The circuits are also being repaired. The question of moving the plant and consolidating it with the city water works plant is still in deadlock in the Council.

SIKESTON.—The Sikeston Ice, Light & Power Company has filed letters of incorporation, with a capital stock of $25,000. The incorporators are Charles D. Matthews, Jr., Edward C. Matthews, Joseph E. Armstrong, Reese B. Boyce and J. Handy Moore.

ST. LOUIS.—Paul D. Cable, president of the General Service & Development Company, announces that he has purchased from the West St. Louis Water & Light Company the lighting franchise obtained by it from St. Louis County Court several years ago, together with all its physical properties. If his plans are developed in full, farming by electric light may be witnessed in St. Louis County within the near future. He intends to light all the main country roads, and wires will be strung into the farmhouses, stables or fields, if so desired by the residents along the route. The franchise is a comprehensive one, giving to the owner the privilege to build in any part of the county.

ST. LOUIS.—In a letter that accompanied the Union Electric Company's proposal to illuminate the public buildings south of Washington Avenue, W. M. Powelson, general manager, declared that if the term of the contract were extended from one to ten years his concern could furnish the energy for 3¾ cents per kilowatt-hour. He recommended that the Board of Public Improvements consider the change. The contracts for lighting public buildings, both north and south of Washington Avenue, were let, the successful bidders being the Laclede Light & Power Company and the Union Electric Company. The former got the contract for the north and the latter for the south district. The Laclede Company's bid was 5½ cents and the Union's 5 cents per kilowatt-hour.

MONTANA.

VIRGINIA CITY.—The Butte Electric Light & Power Company is reported to have petitioned for a franchise to furnish this city with electric light and power.

BIG TIMBER.—The Big Timber Electric Light & Power Company, it is reported, has petitioned for a franchise for water works and an electric light system.

HELENA. — The Helena Power Transmission Company has awarded the first of a series of contracts, aggregating $1,500,000, for the building of a dam across the Missouri River near here to the Wisconsin Bridge Company, of Milwaukee. It is expected that the company will begin the transmission of electric power to Helena, Butte and Anaconda within ten months. About 20,000 horse-power will be developed, and this will be utilized chiefly in the Amalgamated smelters at Anaconda and in mining at points between there and Helena, as well as for lighting and street car purposes in the cities mentioned. The entire product of the present dam is used in the Helena smelters and Butte mines. Additional contracts have been let as follows: The S. Morgan Smith Company, of York, Pa., four pairs of main water wheels, to be constructed of cast iron, and each pair to have a capacity of 4000 horse-power; the Allis-Chalmers Company, of Milwaukee, for furnishing the auxiliary or exciter wheels. It is stated that the contract for the electrical machinery is yet to be let.

NEBRASKA.

ADAMS.—The town is negotiating with parties for the establishment of an electric light plant. The town will use street lights, and business men are taking commercial lights.

GRAND ISLAND.—The Mayor has been authorized to secure an electrical engineer to prepare and submit plans for an electric lighting plant for the city, to be operated in connection with the water works. Later bonds will be issued and the plant built.

NEVADA.

LOVELOCKS.—It is reported that the installation of an electric lighting plant is contemplated.

GOLDFIELD. — The Bishop-Nevada Electric Power & Lighting Company has been incorporated, with a capital of $1,000,000, for the purpose of constructing an electric plant on the Owens River, near the town of Bishop, to transmit power to Tonopah, Goldfield, and Bullfrog. D. Jones, of the J. Jones Exploration Company, may be able to give further information.

TONOPAH.—The Nevada Power Mining & Milling Company, C. M. Hobbs, manager, has contracted with the Allis-Chalmers Company for a Bullock 1500-kw., three-phase generator for use on its Tonopah transmission system. The original installation is well advanced, two 750-kw. National Electric three-phase generators having been ordered some time ago. The prospects for business have increased. Power will be transmitted nearly 100 miles.

RENO.—The Reno Power, Light & Water Company and the Washoe Power & Development Company have been secured by the Fleishhacker interests and ruinous competition in the lighting business at Reno prevented. The Hunter Creek Water Company and the Sparks Water Company will be included in the merger. It is understood that a new company will be incorporated that will probably be called the Union Power, Light & Water Company, and capitalized at $2,000,000. The Fleishhackers are heavily interested in the Truckee River General Electric Company, which supplies electric power for the Comstock mines at Virginia City, and in the American River Electric Company, with transmission lines from near Placerville to Stockton, Cal.

NEW HAMPSHIRE.

FRANKLIN.—Work is now under way on the new reservoir, to be used in connection with the city water system. Electric power will be used for pumping.

PORTSMOUTH.—The contract for the electric power plant at Freeman's Point has been awarded by the Publishers' Paper Company to the General Electric Company. Work will begin at once. This contract involves an outlay of more than $100,000.

LACONIA.—The Laconia Electric Light Company has begun furnishing power for the street railway. The lighting company has secured control of the Meredith plant, and wires will be run from The Weirs to that place before winter sets in. It is the intention of the new owners to use the Meredith plant as a reserve power, to be used as occasion demands. The latest acquisition to the plant is a 225-h.p. engine.

SHELBURNE. — An important deal has been consummated for a new water power plant. The contract has been let to Ward Brothers, of Berlin, for the construction of a dam across the Androscoggin, which at this point is 350 feet wide, and a power house 110x50 feet, the total cost being estimated at between $75,000 and $100,000. It is the purpose of the Berlin Electric Light Company to transmit electric power to Berlin, and it is expected that at least 1200 horse-power will be available from this new source. The power-house will be of concrete and will be fireproof.

PORTSMOUTH. — The Rockingham County Light & Power Company, of this city, which furnishes power for the light of the New Hampshire Company all over the southern part of the State, and also lights this city, has served notice through its counsel, Judge Samuel W. Emery, on Mayor Marvin and City Clerk Underhill that it has brought suit against the city of Portsmouth for unjust taxation of the company's plant in this city. The company was assessed on an appraisal of $451,250, which it claims is overvalued to the amount of $277,818.

NEW JERSEY.

NEWARK.—Morris R. Sherred, chief engineer, it is reported, is preparing estimates for a municipal lighting plant.

ATLANTIC CITY.—An ordinance has passed first reading in the City Council granting a franchise to the Atlantic City & Suburban Electric Company.

KEARNY.—It is reported that an agreement has been reached between the Public Service Corporation and the Lighting Commission on a two-year contract for lighting the streets.

PERTH AMBOY.—The City Council has granted a franchise to the Citizens' Electric Light & Power Company. The company will probably begin work on its plant at once. Engineers, Runyan & Carey, 122 Market Street, Newark.

NEW MEXICO.

SILVER CITY.—The City Council has granted a fifty-year electric light franchise to George T. Schmelzel and associates.

JARILLA.—R. G. Mullen represents a company which proposes erecting power plants along the Sacramento River for a mining camp at Jarillo.

ALBUQUERQUE.—The Union Gas & Traction Company has been incorporated, with a capital of $500,000, for the purpose of constructing and operating gas, oil, electric and water works plants and systems; to operate a system of pipe lines, wires, etc., for the transportation of gas, oil, electricity and water; to own and develop clay, sand, cement and other lands and properties; to operate steam, electric and cable street cars or traction lines. Incorporators: C. H. Pattison, Kansas City,

NEW YORK.

CAMDEN. — The contract for constructing a power house for the municipal electric light plant has been awarded to J. A. Raymond. The building will be ready to receive machinery October 1.

NEW YORK. — The Suffolk County Lighting Company has been incorporated, with a capital of $50,000. The directors of the company are George MacDonald, Charles A. Hickey and William H. Morgan, all of New York City.

CLYDE.—The Clyde Gas & Electric Company has been incorporated to take over the Clyde Gas & Electric Company; capital, $25,000. The directors are P. W. Summers, Ithaca; G. S. Sheppard, and W. T. Morris, Penn Yan.

ROCHESTER. — The Niagara Falls Electrical Transmission Company, of Niagara Falls, N. Y., has applied to Mayor Cutler for permission to erect poles and wires and to construct conduits in the streets, alleys and public places of the city, and to transmit and sell electric power and light.

STILLWATER.—Flood & Sherrill, of Sandy Hill, have secured the contract to construct a concrete dam across the Hudson River at Stillwater, at a cost of about $16,000. About 600 to 800 cubic yards of rock will be excavated. The dam is to provide power for the Hudson Valley Railway and to the mills.

HERMON.—The Hermon Electric Light Company has been organized, with a capital stock of $15,000. J. H. Cullimore, Sr., is president and manager, and W. G. Popple, secretary and treasurer. The plant operates on a 12 o'clock schedule, and supplies 800 16-c.p. lamps and one arc lamp. The main equipment consists of a gasoline engine unit.

LITTLE FALLS.—The P. B. McCaghey Company has been organized by W. J. Berrigan, of Little Falls; J. E. McCaghey, of Sandy Hill, and others. The company has secured contracts from the Paul Smith's Hotel Company to construct two electrical power plants, one at Union Falls, Clinton County, and the other at Franklin Falls, Franklin County.

ROCHESTER.—It is stated authoritatively that the Niagara Falls Electrical Transmission Company, which has asked for a franchise in Rochester, has no connection with the Niagara, Lockport & Ontario Power Company, and that the latter company does not contemplate seeking franchises in Rochester and Syracuse. The Niagara Falls Electric Transmission Company has as its president Mr. Frederick Nicholls, of Toronto. Its vice-president is Frank A. Dudley, of Niagara Falls.

UTICA.—Work has been started on the pump house of the Hudson River Electric Power Company, north of the new power plant on the river bank. The first of the permanent turbines will arrive and will be put in position about October 1. Those now in use are only temporary, and their combined capacity is 2000 kilowatts. The first of the permanent generators to be erected will supply this power alone, and as it will be placed on an extra base in the plant, the work of establishing it will not interfere with the operation of the other turbines.

NORTH CAROLINA.

STATESVILLE, at a recent election, voted $20,000 for water and for improving the electric lighting system of the town.

GREENSBORO.—The Greensboro Electric Company has installed four 300-h.p. boilers, thereby doubling the capacity of its plant in the city.

CONCORD.—The town of Concord has contracted with the Murray Iron Works, Burlington, Iowa, for a 225-h.p. Corliss engine; with the Allis-Chalmers Company for a 150-kw. alternator, and with the Adams-Bagnall Company, of Cleveland, for fifty arc lamps.

FAYETTEVILLE.—It is proposed to expend about $20,000 on the municipal electric light plant and line extension, the work to include the installation of two boilers, 300 horse-power, one or two engines; one 250-kw. alternator and two 120-kw. generators. W. T. Jones, superintendent.

CHARLOTTE.—The Southern Power Company, Charlotte, is making contracts to furnish electric energy to manufacturing plants, and the latest contract is with the Southern Cotton Oil Company at Charlotte, for about 300 horse-power, beginning with the incoming cotton season. The newest development, which is at Great Falls, on the Catawba River, will be completed in eighteen months, according to estimate, and there will be available at that point 60,000 horse-power.

OHIO.

ROSEVILLE.—The Clay City Electric Company has been incorporated, with a capital stock of $10,000, for the purpose of operating a light and power plant.

CLEVELAND.—M. A. Bradley has been granted a permit for the erection of a $48,000 power house at the northwest corner of Ontario and Noble streets.

CARROLLTON.—The Carrollton Electric Company, composed of U. C. DeFord and J. C. Ferrall, has disposed of its plant and property to a stock company for a consideration of $15,000.

READING.—George Hornung, consulting engineer, 612 Johnston Building, Cincinnati, writes that bids will be received October 15 for the construction of a new electric light plant for Reading, to cost about $30,000.

SALEM.—A deal of considerable importance was consummated here by the sale of the entire plant and holdings of the Salem Electric Light & Power Company to E. E. Beam, of Cleveland, and S. D. Gilder, of Cincinnati.

YOUNGSTOWN.—Press reports state that a combination of the railway and lighting companies in and near Youngstown is to be known as the Mahoning & Shenango Railway & Light Company. It will have a capital of about $10,000,000 and control about thirty corporations. Murray A. Verner, of Pittsburg, Pa., is reported interested.

MIAMI. — The Maumee Valley Electric Company is making preparations for the extension of its operations on both sides of the river between the city line and Maumee and Perrysburg, including the two named towns. The company operates the power plant near Miami, that was originally used to furnish electricity for the Maumee Valley Belt Line. It is owned by the Detwilers and George G. Metzger. A franchise will be asked from the councils of Maumee and Perrysburg and an effort made to light every house on both sides of the river between Toledo and the two towns up the Maumee. Wires are now being strung to many summer homes just beyond the city limits.

TOLEDO.—The principal features of the franchise asked by the Central and East Side heating and lighting companies are: Companies to give city bond, Central $25,000, East Side $15,000, to insure good faith and completion of plans in eighteen months; rate for lighting to be 9 cents per kilowatt-hour; city has right to use all of either company's poles or conduits without charge; city reserves right to change prices for heating every five years, lighting every ten years; franchise to run twenty-five years; the Board of Public Service is vested with authority to compel either company to extend its service to any reasonable location. Charles S. Ashley, president of the Central Heating & Lighting Company, it is stated, has announced that extensive improvements are to be made in the company's lighting plant, which is located in the Meredith Building.

OKLAHOMA TERRITORY.

WEATHERFORD.—The contract for the erection of the new power house has been awarded to A. O. Campbell, of Oklahoma City.

SHAWNEE.—Willis Fertig, of Titusville, Pa., has been granted a franchise for an electric light plant here. He will also operate and extend the present electric street railway.

PAWHUSKA.—The Pawhuska Electric Light, Ice & Water Company has filed articles of incorporation stating the capital stock to be $25,000. J. W. McLoud, of Little Rock, Ark., and B. Erick, of Fort Wayne, Ind., are the promoters of the project.

OREGON.

DRAIN. — The Skelley Lumber Company is about to apply to the Town Council for a water and light franchise.

PENNSYLVANIA.

WILLIAMSPORT. — The Lycoming Electric Company has taken out a permit to erect a new power house, to cost about $75,000.

CAMDEN.—The Wyoming Gas & Electric Company has been formed to operate and maintain gas and electric lighting plants; capital, $15,000. Incorporators: John A. MacPeak and others.

SINKING SPRING. — The Cumru Township Electric Light & Power Company has been formed, with William F. Krick, of Sinking Spring, as president, to furnish electric light in Sinking Spring and Shillington. Capital, $5,000.

GREENCASTLE.—The Greencastle Light, Heat & Power Company (Harry C. Hollinger, Philadelphia, treasurer) has been incorporated, according to reports, with a capital of $10,000, to furnish light, heat and power to Greencastle.

CONNELLSVILLE. — A deal just completed makes a change in the ownership and management of the Interstate Electric Company of Connellsville. On account of a press of duties as superintendent of transportation of the West Penn Railways Company, J. W. Brown, who organized the company, and Frank Zimmerman have sold their stock to J. M. Fisher and Charles O. Moser, who were electricians for the company.

HUNTINGDON.—The Juniata Water & Water Power Company is reported incorporated, with offices at Huntingdon and Philadelphia. The company has purchased property for the erection of a hydro-electric power plant in Warrior Ridge Gap, and construction will, it is said, be started as soon as plans can be prepared. The cost of the proposed plant will be about $1,000,000, and power will be transmitted to Huntingdon, Tyrone, Altoona and other towns in this vicinity. S. L. Brumbaugh, president, Philadelphia.

YORK HAVEN.—The York Haven Water & Power Company has placed a force of men at work to construct the poles for the line by which it will transmit electric power to Middletown, Harrisburg, Pa., and other points in Dauphin and Lancaster counties. Agents of the company are still engaged in securing rights of way for the construction of the proposed line, and it is said that the corporation will soon have all of the necessary rights so that it can dispose of its power across the river. Preliminary work is now being done for the laying of the cable beneath the Susquehanna River from the York Haven plant to a point on the Lancaster County shore, where a terminal station will be built.

RHODE ISLAND.

MOOSUP.—The Consolidated Railroad Company is proposing to buy the Packer power privilege at the Quinebaug Bridge, a few miles west of Moosup, with a view to building an electric power plant to furnish light and power for the tramway, and also for the villages of Plainfield, Wauregan, Central Village and Moosup.

SOUTH CAROLINA.

COLUMBIA.—The Hatton Shoals Power Company has been organized at Anderson with a capital of $150,000.

GREAT CATAWBA FALLS.—Three hundred men are already at work on the immense water power development of the Southern Power Company at Great Catawba Falls in upper South Carolina. The entire developments along the Catawba will represent an outlay of perhaps two million dollars.

SPARTANBURG.—T. D. Lawshaw, of the firm of Lawshaw & Lawshaw, Spartanburg, S. C., is superintending the developing of a hydro-electric transmission on Meherrin River, at Emporia, Va. From 3000 to 5000 horse-power will be generated and will be used for operating a cotton mill, city lighting, etc.

SOUTH DAKOTA.

GROTON.—The Groton Light, Heat & Power Company (C. D. Jones, secretary), proposes constructing a central heating plant. H. E. Miles, engineer, Groton.

PLUMA.—Phillips & Bartlett, of Deadwood, are stated to have secured the contract for erecting a power house at Pluma for the Consolidated Power & Light Company; probable cost, $20,000.

SIOUX FALLS.—The Queen City Electric Light & Power Company has been incorporated at Pierre with a capital of $300,000. Incorporators:

H. J. Hanford, Chicago, Ill.; P. Curtis, Norwalk, O.; W. G. Mack, of Sioux Falls, and others.

TENNESSEE.

KNOXVILLE.—Bids are to be received, according to reports, for lighting the streets on three, five, seven and ten-year periods.

CLINTON.—The City Council is reported to have passed on first reading the ordinance granting William B. Crawford, of Oliver Springs, a franchise for water works and an electric light plant.

BRISTOL.—Following a meeting of the directors of the Bristol Gas & Electric Company, it was announced that the General Electric Company has purchased a large interest in the properties and franchises of the local company which owns all the gas, electric and street railways in this city and Bristol, Va.

GREAT FALLS.—The Great Falls Power Company, proposing a big water power development near Nashville, Tenn., has asked for an extension of time limit of the franchise and will likely be favored. Already sufficient money has been promised, it is said, for the construction of the electric plant which the company proposes to build, and from which power will be furnished to Nashville.

CHATTANOOGA.—Local press reports state that the plans for the lock and dam and the power plant of the Chattanooga-Tennessee River Power Company, to be constructed at Hales bar in the Tennessee River, at a cost of about $3,000,000, are now ready for inspection of contractors at the office of the U. S. Engineer, in the Loveman Bldg. Bids will probably be called for at once. John Bogart, consulting engineer, 16 Exchange Place, New York, N. Y.

KNOXVILLE.—The board of directors of the Knoxville Power Company has held its annual meeting. Plans for the proposed power plant to be erected on Little Tennessee River have been discussed. The following officers were elected at the meeting: President, Charles H. Treat, New York City; vice-president, John T. Wilder, Knoxville; secretary, John F. Barry, New York City; assistant secretary, L. M. Parker, Knoxville. The Knoxville Power Company will expend $3,500,000 in building the plant.

TEXAS.

GONZALES.—The Citizens' Electric Light & Power Company has increased its capital stock from $5000 to $10,000.

EAGLE PASS.—The Texas-Mexican Electric Light & Power Company has increased its capital stock from $20,000 to $40,000.

EL PASO.—W. A. Hawkins, of El Paso, and associates, are considering the matter of erecting electric power plants on the Sacramento River in New Mexico.

GREENVILLE.—Extensive improvements are to be made to the city electric light and power plant of Greenville. A proposition to sell the city plant to parties who propose to construct an electric street railway system here is being considered.

FORT WORTH.—At the recent election held for the purpose of voting on the question of granting a franchise to Judge Armstrong to establish an electric light, power, gas and heating plant, the people voted in favor of granting the franchise.

BAY CITY.—By order of the court the Bay City Ice, Light & Power Company's plant will be offered for sale to the highest bidder by Special Commissioner Judge W. C. Carpenter early in September. This plant is very finely equipped, having cost in the neighborhood of $40,000. It would no doubt have been a money-making institution from the start, but through over expenditure on buildings and fine machinery it became deeply involved and was forced into the hands of a receiver. During the past few months it has been showing nice profits and as the town grows and as new territory is opened up by the Brownsville road now building it will prove to be a profitable investment.

UTAH.

VERNAL.—The City Council has granted a franchise to G. H. Seth for an electric light, heat and power plant.

EPHRAIM.—The city has recently installed a 500-horse-power Pelton water wheel operating under 640-foot head for running the generator which furnishes the city lighting.

OGDEN.—L. B. Spencer, of Ogden, has filed with the state engineer, at Salt Lake City, an application for a water right on Ogden River. He intends to construct a power plant to furnish both power and light in Ogden.

RICHFIELD.—A. J. Paulson, of Richfield, has filed with the state engineer, at Salt Lake City, an application for a water right on Sevier River. It is proposed to install a power plant capable of developing 450 horse-power.

SALT LAKE CITY.—J. H. Bigger and J. E. Hill have applied for permission to develop power for electrical purposes from American Fork Creek. They propose developing 950 horse-power for electric lighting and for working machinery in the American Fork mining district.

VERMONT.

RUTLAND.—The annual meeting of the Rutland City Electric Company has been held. These directors were elected: S. M. Hamill, A. H. Jackson and H. M. Francis, of Schenectady, N. Y.; F. M. Butler and George S. Haley, of Rutland. Mr. Hamill was elected president, Mr. Jackson vice-president, Mr. Francis treasurer, Mr. Butler secretary and Mr. Haley general manager.

READSBORO.—Plans are under way for the erection of an electrical power plant on the Deerfield River, north of the east portal of the tunnel. A charter for the new company has been secured from the State of Vermont, under the name of the Deerfield River Power Plant Company. Among those interested in the project are W. S. Morton, of Hartford, Conn.; James H. Roraback, of Canaan, Conn., and Faxon Bowen, of Readsboro, Vt. The plant will be located near Readsboro in Vermont, and will cost about $1,000,000.

VIRGINIA.

LURAY.—Preliminary surveys have been made for developing the Shenandoah River near Luray, and about 500 horse-power is found available. D. G. Strickler, F. G. Grave and other parties in Luray are interested.

WASHINGTON.

CASHMERE.—It is reported that F. C. Barnum, of Cashmere, is endeavoring to obtain a franchise to erect an electric light plant here.

SUNNYSIDE.—The question of constructing water works and an electric light plant is reported under consideration here. The probable cost is $15,000.

ARLINGTON.—Thos. Moran is reported to have secured a franchise for a light and water system, the power to be developed from the falls of Jim Creek.

EVERETT.—The Mayor has been directed by the City Council to appoint a committee to investigate the possibility of establishing a municipal electric light plant.

SEATTLE.—The Stanley Electric Manufacturing Company has sold a carload of lighting transformers to the city of Seattle for use in connection with the municipal lighting plant.

TACOMA.—The City Council Committee on fire and water has recommended that the arc circuit, which in the report of the City Engineer is estimated to cost $5,000, be installed immediately.

REARDAN.—The Reardan Light & Power Company, it is reported, has been incorporated with a capital of $5,000 to engage in the light and power business. Incorporators: Frank Bradley, John Fields, John Rayman and others.

PROSSER.—The Prosser Falls Land & Power Company has started to build an addition to its dam across the Yakima River at this point, which, it is expected, will prevent a recurrence of the present low water next year. The stream at this point is now flowing but 200 second-feet, the smallest in its history, and if the dam had not been put in last year Prosser would now probably be without water works, irrigation or electric lights.

WISCONSIN.

PHILLIPS.—The Phillips Light, Water, Heat & Power Company petitioned for a franchise.

SHEBOYGAN.—The Sheboygan Light, Power & Railway Company is figuring on plans for extensions and new suburban lines.

MENASHA.—It is quietly rumored that this city is to have a municipal lighting plant. While there has been no public announcement it develops that certain officials have been putting in labor and research along this line for the past year.

MILWAUKEE.—The County Trustees are discussing the question of providing for a central heating, lighting and power plant and extending the city water mains to the Wauwatosa institutions. Alderman Stiglbauer's resolution providing that $60,000 be set aside from the water fund to purchase a site for a municipal lighting plant, was unanimously adopted by the finance committee.

CANADA.

PEMBROKE.—The Pembroke Light, Heat & Power Company has been formed to acquire water power on the Black River, for the purpose of adding to the present electric light system.

NAPANEE.—W. A. Grange, town clerk, states that plans and specifications have been prepared by R. S. Kelsch, New York Life Building, Montreal, Que., for the proposed municipal electric light plant; probable cost, $35,000.

MEXICO.

CITY OF MEXICO.—Modesto R. Martinez, on behalf of Andres Matienzo, has secured a concession to utilize the waters of Atoyac River in the State of Puebla for power purposes.

ALLENDE.—A new electric light and power plant is to be installed at Allende. The organization of the company was promoted by Enrique Guerra, of Ciudad Porfirio Diaz, State of Cohuila.

CITY OF MEXICO.—Parties, whose names are not stated, have applied to the Federal Government for a concession to establish an electric power plant on the San Andres River in the State of Zacatecas.

CHILPANCINGO.—The Belgian syndicate, which recently purchased the Jeronimos waterfall, situated on the Pedrenas River, in the State of Guerrero, is preparing to erect a large electric power plant at the fall. The power will be transmitted to cities and mining camps of the State.

TAMPICO.—The Luz Electrica de Tuxpam is the name of a company which has been organized at Tuxpam for the purpose of installing and operating a new electric light and power plant. Among those interested in the enterprise are Luis Montoto Carsi, Antonio Alvarez, Manuel Perez, Santos Gonzales and Felix Costilla, all of Tuxpam.

CITY OF MEXICO.—It is reported that the Mexican Power Company, with an authorized capital of $10,000,000 operating under a New Jersey charter, has been organized and is preparing to utilize the water power of three rivers in the State of Mexico near Toluca. It will furnish electric power to this city, estimated at 90,000 horse-power.

CITY OF MEXICO.—The Mexican Light & Power Company will erect fifteen station and storage buildings along its power transmission line between the main power plant at Necaxa and the City of Mexico. These stations will be used for the accommodation of the linemen and watchmen who will constantly patrol the line and for the storage of materials.

CITY OF MEXICO.—It is learned that a strong company is being formed in London and Berlin for the purpose of installing a large electric light and power system in the City of Mexico. It is reported that representatives of those back of the company have been in the City of Mexico securing contracts for the furnishing of power and that enough of these have been secured to insure the financial success of the enterprise. The names of the parties interested have not yet been made public.

American Electrician.

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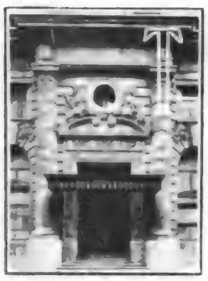
POWER AND LIGHTING EQUIPMENT OF A MODERN HOTEL.

ENGINEERING FEATURES OF THE GOTHAM AT FIFTH AVENUE AND FIFTY-FIFTH STREET, NEW YORK CITY.



THE Hotel Gotham, which has recently been completed at the southwest corner of Fifth Avenue and Fifty-fifth Street, New York City, at an expense of nearly three million dollars, ranks among the most elaborate and costly of the numerous handsome hotels in New York City. Like the larger portion of the buildings of this class which have been recently erected, the Gotham is provided with its own mechanical and electrical equipment, which corresponds with the complete arrangement for the comfort, safety and convenience of its guests. The building is 21 stories high, and needless to say, fire-proof throughout. As is usually the case where ground space is very valuable, the mechanical equipment is of necessity compactly arranged in the basement, reminding one of machinery aboard ship, so that suitable photographs for purposes of illustration were difficult to obtain.

The general layout of the plant is shown in the plan view, Fig. 2, which is drawn to a scale of 1/16 inch to the foot. A view of the main engine room is given in Fig. 1. Steam is generated in five 200-h.p. boilers of the Manning type. These are connected by 7-in. bends to a 12-in. header running the length of the boiler room. A 12-in. high-pressure steam main, connected at right angles to this header, runs into the engine room and supplies the engines and elevator pumps. After leaving the engine room, the high-pressure steam main continues as a 6-in. main for feeding auxiliary apparatus. Valves are provided in the large main and header to shut off any of the boilers desired, any of the branches, and in addition, a 6-in. gate valve is provided where the main changes to 6 inches in size. A 4-in. branch is taken off the 6-in. main and connects through a 2-in. by-pass with the exhaust pipe. A pressure-reducing valve is arranged on this main to reduce the pressure from 100 pounds to 5 pounds; this valve is provided with a by-pass. A 2-in. connection with a gate valve on the same leads from this 4-in. branch into each of the two 300-h.p. feed-water heaters.

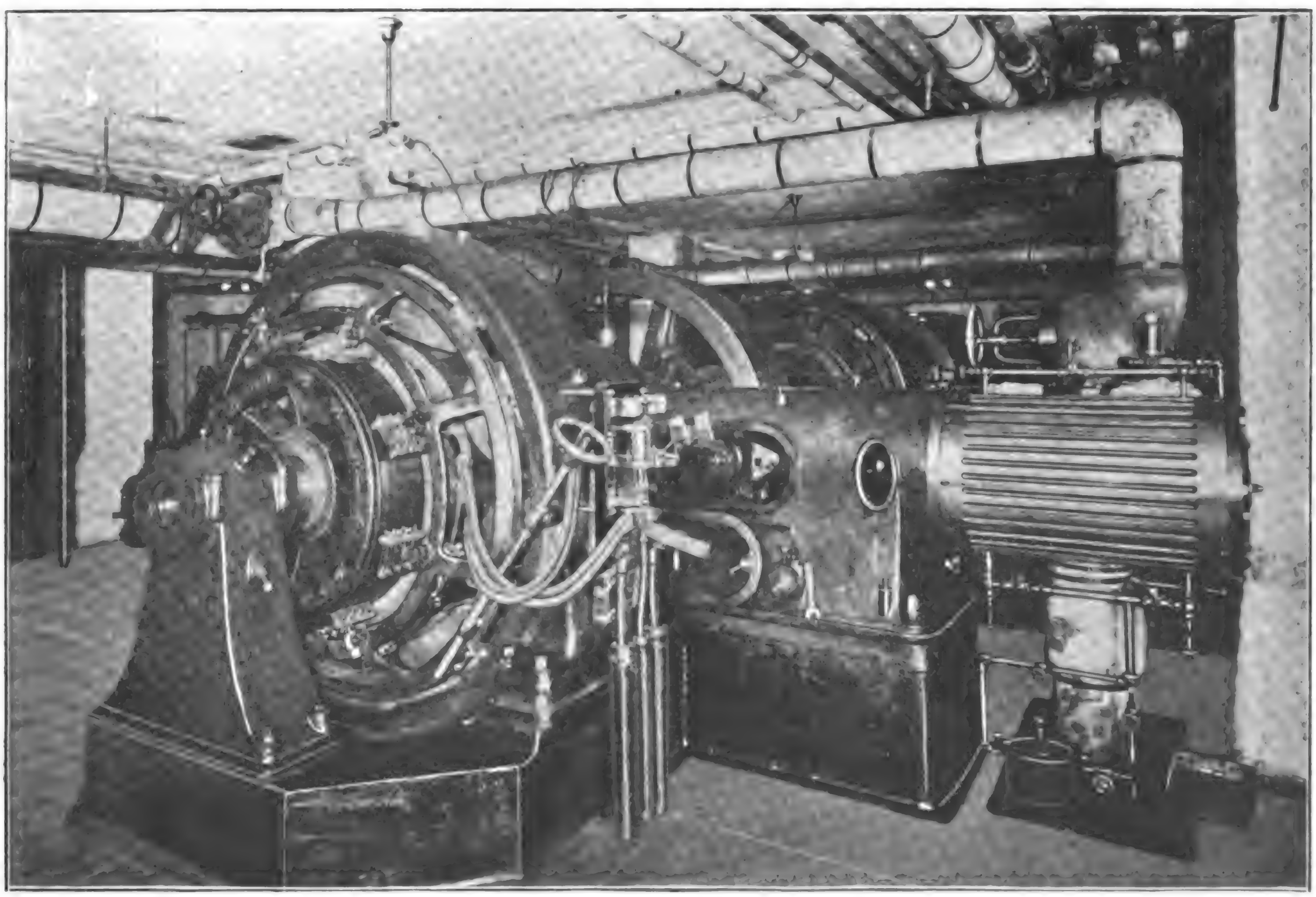


FIG. 1.—ENGINE ROOM OF THE GOTHAM HOTEL.

Full-sized branches are run from the main to each of the steam pumps and to each of the electric generating sets. The

branches to the latter sets are 6 inches in diameter and each is provided with a valve close to the main and with a throttle valve at the engine. The piping of the boiler feed pumps is cross-connected for both generator and hand control.

The main exhaust pipe is 12 inches in diameter and is located in a trench in the engine room rising with a long bend beside the muffler tank. The connections into this tank are through a tee with a long bend inside the tank and with a long bend to the by-pass connection. These connections are provided with the necessary gate valves. The exhaust from the boiler feed pumps enters this 12-in. main before it reaches the muffler tank. From the muffler tank the exhaust extends to the bottom of the ex-

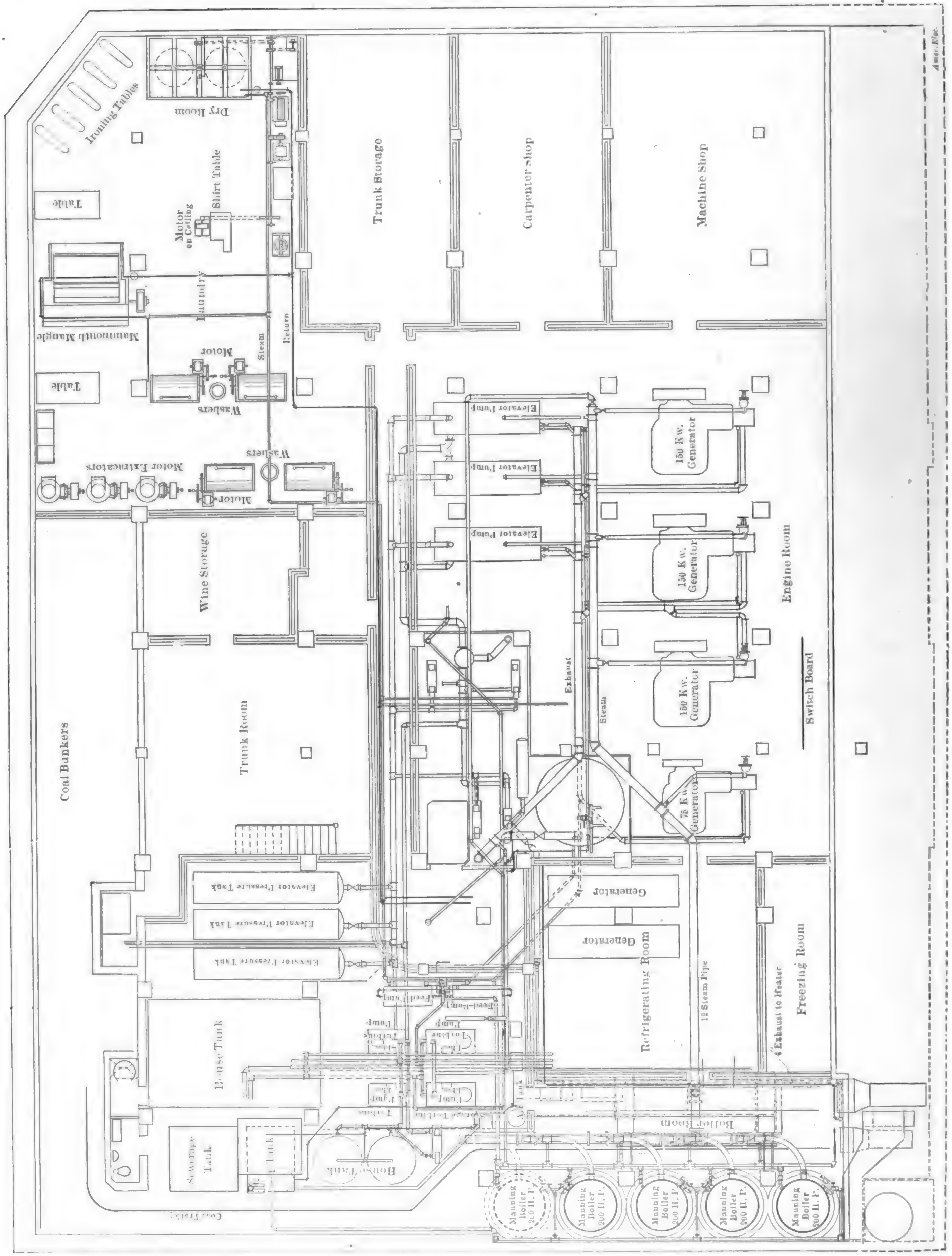


FIG. 2.—PLAN VIEW OF BASEMENT OF THE HOTEL GOTHAM, SHOWING THE MECHANICAL LAYOUT.

haust riser with a drop leg on the same, and a 12-in. supply branch is connected to this line feeding two 10-in. branches to the two feed-water heaters and one 10-in.branch with a flange connection to the header of the refrigerating system generators. The vertical portion of the exhaust riser is of light-weight wrought-iron pipe and is anchored at the cellar, the ninth and twentieth floor levels and provided with two sleeve expansion joints. At the twentieth floor level there is a tee and a gate valve for the heating system, together with a back-pressure valve and exhaust head. The exhaust pipe runs for the main part in trenches where it is supported on graded rollers, with a drip connection at the point where it rises to the exhaust muffler.

A 1½-in. drip main runs beside the exhaust pipe to collect the oily drips from the engines and pumps. At the muffler tank this drip main is enlarged to 2 in. and a branch leads into the oil chamber and into the return chamber of the muffler tank; from here the main extends into the drip tank. A 2-in. drip line is installed on the cellar ceiling, with ½-in. branches and traps to receive the condensation from all steam jackets used in the kitchens. This main runs into the return chamber of the muffler tank. A 2-in. main also runs on the cellar ceiling from the laundry and discharges into the return chamber of the muffler tank. This main is provided with ¾-in. branches to all steam jackets and traps in the laundry. In addition, there is a 1½-in. main carried beside the exhaust pipe with ¾-in. branches and traps to take care of the clean condensation from the engines and from the high-pressure steam line. This main discharges into the return chamber of the muffler tank. All of these drip mains are provided with valves on all branches.

FIG. 3.—MOTOR-DRIVEN MANGLE.

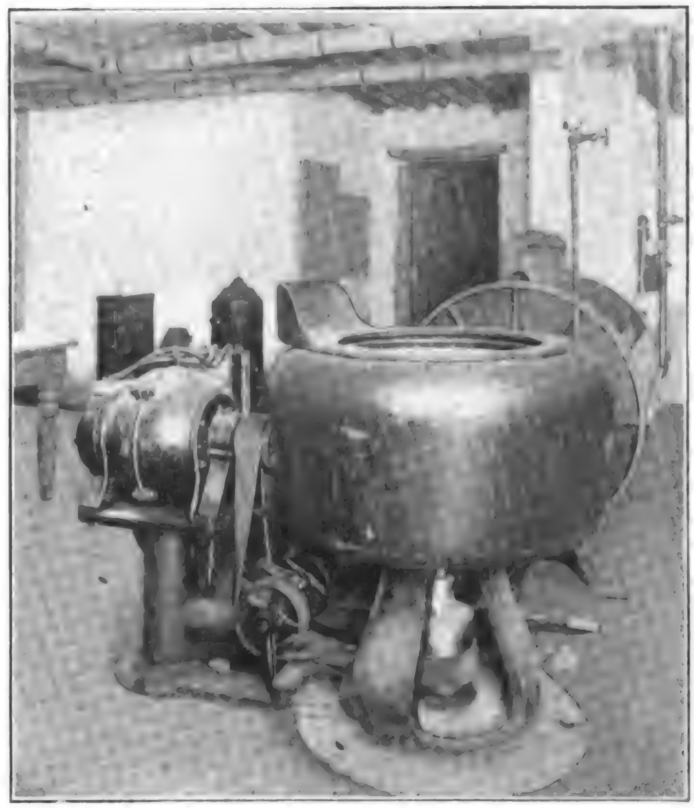


FIG. 4.—MOTOR-DRIVEN EXTRACTOR.

Water for boiler feeding purposes is taken from the city mains. A 4-in. main runs from the return chamber, through a pump governor, to the boiler feed pumps, and a similar sized main is connected with the suction tank. From the discharge side of the pumps a 4-in. main runs in front of the boilers with a 2-in. connection to each boiler, this connection being provided with a gate and a brass check valve. All of the valves used in connection with the feed-water piping are of the gate type and the piping is of galvanized iron, erected with valves and flanges so as to be readily taken down.

FIG. 5.—WASHING MACHINERY IN LAUNDRY.

Two and one-half inch blow-off branches lead from each boiler into a 3-in. main of galvanized iron connecting with the blow-off tank. From the blow-off tank a 4-in. connection leads to the sewer outside of the building, with two tees and a gate valve between and a gate valve on each tee branch for a by-pass to the sump pump. A vapor pipe from the blow-off tank is connected into the safety valve pipe. Each of the safety valves is connected to a vapor line discharging into the smoke stack, and a ½-in. branch leads from the same opening into the boiler room. The sump pumps are connected with suctions running to the

blow-off tank, into the sump, into the drip tank, and with a branch connected to the

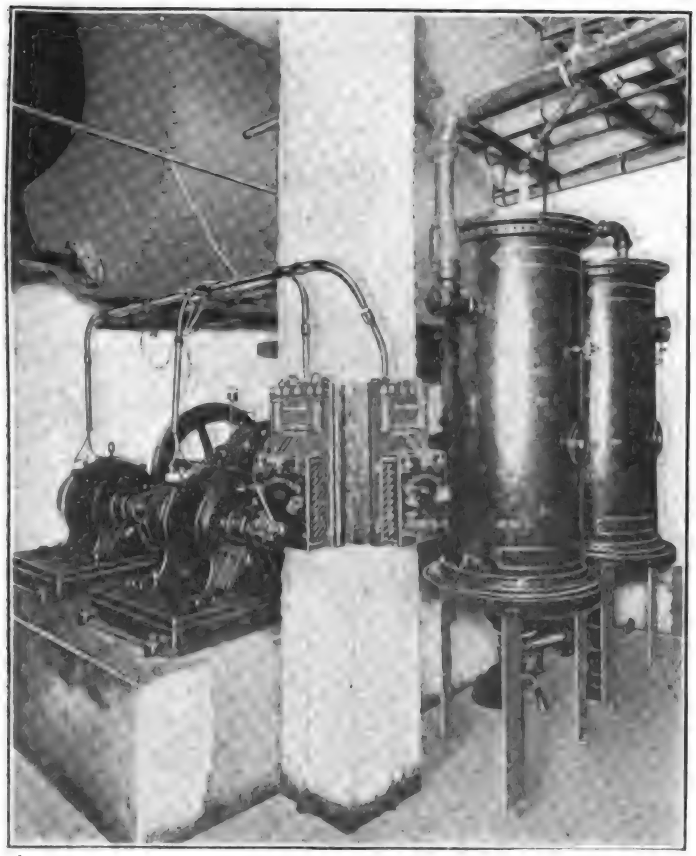


FIG. 6.—VACUUM CLEANING EQUIPMENT.

sewage tank. Each of these branches is 3 inches in diameter and provided with a gate valve, the suction into the sump being also provided with a mushroom strainer. A 4-in. galvanized-iron pipe runs from the discharge side of the blow-off tank to the sewer. The muffler tank is of special design, combining a muffler tank, grease extractor, return tank and feed-water heater, fitted complete with the necessary diaphragm, baffle plates, water trays, cast-iron flanges, manholes, water columns, etc. All the steam piping, heaters, tanks, etc., with the exception of the sewage tank, are covered with molded sectional heat insulators containing 85 per cent. of magnesia with canvas jackets and Russia iron bands.

In the engine room are located four electric generating sets, as well as the switchboard for the light and power service. The generators are all compound-wound machines and were furnished by the Sprague Electric Company of New York. Three of these are of 160 kilowatts capacity and the other is of 75 kilowatts capacity. They all generate direct current at a potential of 250 volts. The generators are direct-connected to non-condensing engines built by the Ball Engine Company, of Erie, Pa. The light and power service of the hotel is operated on the two-wire system, 225 volts being used for both lights and motors. The motors are used chiefly for driving pumps, fans and laundry machinery and in the kitchen.

The switchboard is of polished white Italian marble two inches thick. The board is made up of five panels, enclosed in a bronze frame, the back being encased by a screen. The two generator panels each contain two double-pole circuit-breakers, two single-pole knife switches for equalizer connections, two recording wattmeters, two rheostat handles for generator rheostats on the back of the board, two ammeters and one voltmeter. There is also provided a multiple voltmeter switch for ground detector service. High and low-pressure steam and air gauges are also mounted on the switchboard. These correspond in finish to the other instruments. No fuses are placed on the board, a separate fuse panel being provided in the rear for that purpose.

Provision is made for thirty main feeder circuits, besides four generator circuits, but five of the feeder circuits are at present blank. The circuits are arranged in the following order: Service power, basement power, cellar and basement power, engine room lights, restaurant and palm room, ice room lights, boiler room and pumps, café, service lights, bakery, service lights, kitchen, laundry power, ice room power, pump room power, roof fans, apartments (west), hall (all night), apartments (east), reading and ball room, pantry heaters, public hall, apartments (north), restaurant and palm room.

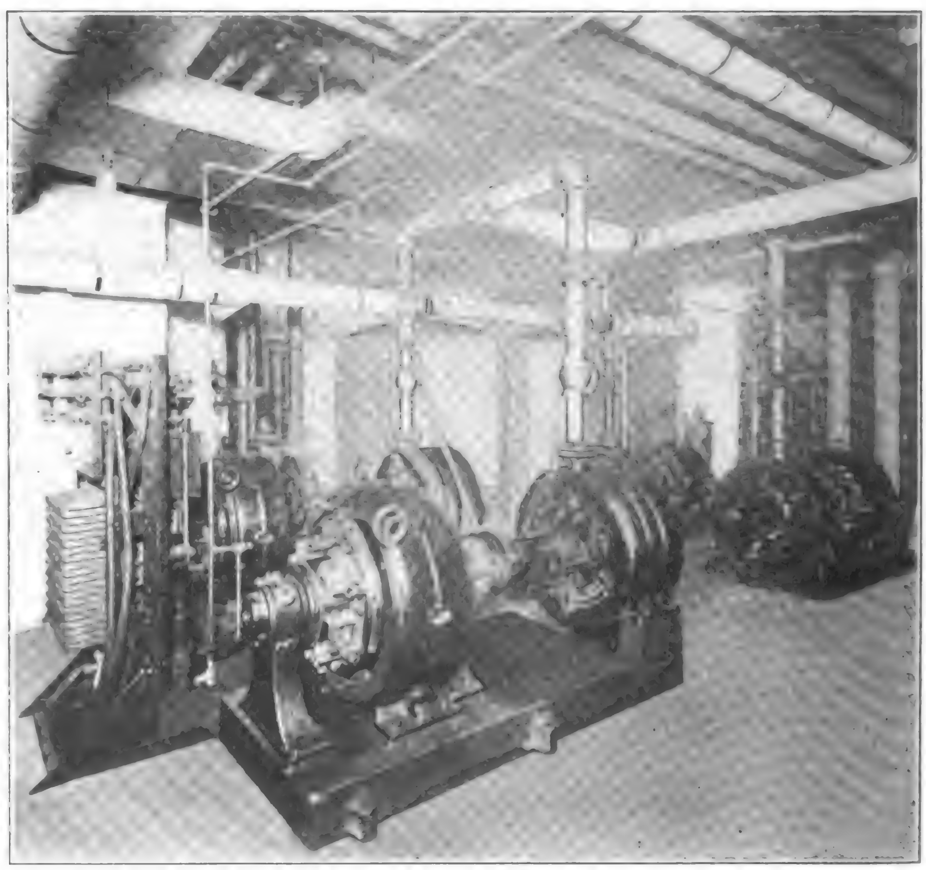


FIG. 7.—MOTOR-DRIVEN CENTRIFUGAL PUMPS.

So far as the wiring system is concerned, the hotel may be conveniently divided into three distinct portions—the working or service portion, the public portion, and the apartment or bedroom portion. The latter comprises usually everything above the first or second floor, the basement and cellar being devoted to service, by which is meant the kitchen and serving rooms, storage rooms, machinery, etc. The public portion includes the café, restaurant, palm garden, ball rooms, etc. The kitchen and serving rooms are effectively lighted by means of cluster fixtures and drops, while the engine, boiler, pump and other machinery rooms are lighted by drops and ceiling clusters. The public portion is, for obvious reasons, sumptuously furnished and artistically lighted, effect rather than efficiency being sought. The lighting of this portion is on a larger and more splendid scale than the rest of the hotel. The restaurant is lighted by ceiling and bracket fixtures with individual lights for the tables, attachment plugs being provided for that purpose. The ball room and palm garden have, in addition, very ornate candelabra fitted with miniature lamps. The rooms of the upper floors are lighted by side and ceiling outlets, the average rooms containing from eight to ten lights. The corridors throughout are lighted by ceiling outlets. Over six thousand 235-volt incandescent lamps are connected up, the major portion of these being 16 candle-power, while smaller candle-power lamps are used for decorative purposes.

The motors used for driving the auxiliary machinery are all of Sprague make. There are two house and two fire pumps, which are of the Worthington centrifugal type, and these are driven by two 20-h.p. and two 40-h.p. direct-current motors respectively. Two 3-h.p. motors are used to drive the sump pumps. A vacuum cleaning system is installed for cleaning the carpets, etc., throughout the building. This apparatus is shown in Fig. 6 and is driven by two 7½-h.p. round-type motors through silent chain drive. A 2-h.p. motor is connected to a shaft in the kitchen, operating ice cream freezers. Numerous other kitchen utensils are driven through motor drive. In the laundry, views of which are shown in Figs. 3, 4 and 5, there are four 2-h.p. motors driving washing machines, three 3-h.p. motors driving extractors, one 5-h.p. motor connected to a main line shaft operating irons, and one 3-h.p. motor operating a mangle. There is also a motor driving a collar and cuff machine, starch mixer, drying fans, etc. There are numerous fans about the building, all of which are motor-driven. These are given in the accompanying table:

Location.	Size of Fan.	Style.	Motor.
Kitchen	90-in.	Exhaust.	4-h.p.
Laundry	60-in.	"	1-h.p.
Billiard room	50-in.	"	1-h.p.
Restaurant	90-in.	"	4-h.p.
Ball room	70-in.	"	3-h.p.
Dumbwaiter shafts	3, 60-in.	Cone.	3, 2-p.h.
Store room	48-in.	"	1-h.p.
Locker room	24-in.	Exhaust.	¼-h.p.
Basement	18-in.	"	⅛-h.p.
Office	18-in.	"	⅛-h.p.
Kitchen range	24-in.	"	¼-h.p.
Roof	7, 42-in.	Cone.	7, 1-h.p.
Laundry	60-in.	"	2-h.p.

All the wiring for electric lights, call bells telephones, and for power is enclosed in "Loricated" conduit. The panel boards throughout the building are of ¾-in. white marble encased in iron boxes provided with lugs for the attachment of the face panels and doors. They have in all cases copper conductors secured on the faces with Noark fuse carrier combination and name plates designating the circuit. The boards controlling the lights on the first and second floors are provided with knife switches. Boxes are provided of such a form as to leave a space on the back of the board for the wiring where the depth of the pocket admits; elsewhere the wire is passed out at the top and bottom with room on the sides of the boxes for the circuits. Flush switches are used to control individual lights, and for surface work in the cellar and basement double-pole Hart switches are used.

The General Building & Construction Company, of New York, were the general contractors for the building and the Contractors' Electrical Company, of Brooklyn, had charge of the electrical work; the Baldwin Engineering Company, of New York, were the contractors for the steam and heating equipment. Mr. C. K. Van Etten is the chief engineer of the Hotel Gotham to whom we are indebted for courtesies extended in the preparation of this article.

British Gas Engines.—It is estimated that one-third of the gas made in Great Britain is used in driving engines.

INCREASING PROFITS OF A CENTRAL STATION.

BY GEORGE E. WALSH.

The utilization of exhaust steam for heating purposes at the central station in small towns and cities has in the last year or two been tried experimentally, and the results justify under certain conditions this method of economizing in by-products. The distribution of steam through street mains and pipes for heating offices and private residences has developed rapidly, and today there are upward of 500 companies in the field of district steam heating. Customers who use this outside steam supply have the advantages of cheaper rates than when the boilers are located in the building, a steadier supply of steam for heating, increased safety from fire dangers, no dust or ashes from coal or other fuel, and no engineers or firemen to look after. So far as the district steam supply companies are concerned they effect a saving in cost of labor, boiler insurance, cost and kind of fuel, and general depreciation of plant.

What applies to the strictly steam supply companies is equally true of electric light and power plants where steam heating is looked upon as a by-product. In order to secure fair profits without overcharging customers for electric light and power, it is quite essential in towns of 20,000 or more inhabitants to utilize every possible economy for securing profitable results. The utilization of the exhaust steam for heating purposes has only lately attracted the attention of central station engineers.

The central station company has usually greater advantages in supplying steam for heating purposes than the independent steam plant. The electric light company has business relations with numerous customers which makes it comparatively easier to present a proposition for supplying steam heat for their houses and offices. Some electric light companies which have entered this field have recently been forced to increase the size of their plant in order to meet the demands upon it, although six months ago their electric output barely paid a profit on the investment.

Steam exhausted from the engine can be economically distributed to customers for heating purposes and the consensus of opinion among steam and electrical engineers in the district heating field is that exhaust steam should be sold on the basis of live steam. Even at the cost of producing live steam and distributing it through the mains, the price will be much lower than it would cost individuals to produce it. The cost of producing the live steam must be determined and fixed and meter charges made accordingly.

Some central station companies can save this waste steam by simply installing the underground mains and piping the buildings of customers. In the construction of new central stations engineers are making designs with reference to this combination of lighting and heating, and in the near future nearly every electric light plant will likewise be a steam heating station for the distribution of heat to customers. The service is growing so rapidly in favor in small towns and cities that owners of old plants are studying the situation with a view to changing their machinery to secure this new source of profit.

In old plants where the engines operate as condensing units, the condensers are detached during the heating months, and during the summer months they are operated condensing. Arrangements are also made so that the engines can operate part condensing and part non-condensing. When the full amount of steam is not required the changeable nature of the plant will thus insure greater profits. In some stations where the installation of engines is not sufficient to supply all the steam needed for customers, additions to carry the load have proved profitable. That is, there is a profit in supplying steam heat alone, and where the exhaust from the electric light plant is not sufficient it is economical to increase it. The enlargement of the plant so that live steam can be supplied where the exhaust is insufficient has frequently demonstrated the economy and value of this phase of the business.

The methods of charging for steam heat supplied are various, but the meter system is the only satisfactory one both to consumers and producers. By estimating the cost of production of live steam it is possible to establish a rate that will prove profitable. By using meters the charges are automatically adjusted to the different classes of buildings. The varying demand for steam heat during the different hours of the day can soon be ascertained by the curve sheet plotted from the reading of the meters. In this way it is possible to estimate in advance the comparative demand for steam at different hours so the use of all the engines can be regulated without waste of energy.

The cost of evaporating 1,000 pounds of water at the station, including cost of coal, labor and fixed charges, will vary in different parts of the country, but the price charged to consumers should cover this and leave a fair margin for profits. Not all companies charge according to meter reading, but by the number of square feet of radiation. A fixed annual price is made by this system for each square foot of radiation installed, with usually a different charge made for direct, indirect and economizing coil radiation.

The People's Gas & Electric Company, of Defiance, Ohio, has a hot water circulating system installed in connection with the electric light plant with charges to consumers based upon the square feet of radiation. Nearly 2000 feet of two-inch main pipes are laid underground by this company, and upward of 2500 feet of four-inch pipe. In this plant the exhaust steam from the engine is carried to an open heater where the water is heated to 160°. An ordinary boiler feed pump is used for circulating the hot water which is distributed to houses from two to three thousand feet distant. The charges are based upon the number of square feet of radiation installed in each house, and the returns from the

exhaust steam have proved very profitable.

The Lima & Toledo Traction Company, of Ohio, has likewise installed a steam heating plant in connection with its central station, and the utilization of waste steam for heating has added materially to the profit of the enterprise. This company bases its charges upon the cost of live steam, and supplies it to customers at meter or fixed annual charges, at rates which leave a good margin for profit. Where the charges are based upon a fixed annual rate per thousand cubic feet of space heated, it has been found from experience that a careful differentiation in buildings and rooms must be made. The character of the rooms to be heated is very important. Where the exposure to cold winds is on the north side, the amount of steam required to heat them is nearly double that demanded for rooms with a southerly outlook. Moreover, a modern fire-proof building is apt to be proof against dampness and winds, and rooms in it require far less steam to heat them. Thus it may be that unless the character of the buildings and rooms are carefully considered, the fixed annual charge per thousand cubic feet of space to be heated will leave no margin for profit. It is moreover an incentive on the part of the consumer to waste steam. When a fixed charge is demanded the consumer has no reason to economize in the use of steam. The radiators are kept hot at all times of the day and night, and if the heat is too great all the windows are thrown open. The waste of heat is thus enormous and often unnecessary. Again there is the uncertainty of our seasons to consider. An open winter would make the charges just the same, and the same amount of steam would be wasted. The gain would be to neither consumer or producer. Where charges are made according to the square foot of installation, the tendency of builders and consumers is to reduce the amount of radiation to a point where unsatisfactory results are obtained. To decrease the fixed charges the installation is often made insufficient, and the complaint is that the steam service is not satisfactory.

It will appear from these varying conditions that the meter system of charging is the most satisfactory for both parties, and where the rate agreed upon is reasonable it results in profits of a substantial nature. This of course presupposes the basing of charges upon the cost of producing live steam and not upon what the exhaust steam may seem to be worth. Considered purely as a by-product central station managers have in the past sold steam on this basis and found in the end that it proved unprofitable. The cost of installing the mains and pipes, and the additional consumption of fuel to keep up the supply at certain hours of the day, increases expenses so that the by-product may become a source of trouble and loss rather than of gain.

The heating season in our Northern States extends from seven to eight months, but during only about half this time will the full capacities of the plant be demanded. Where the exhaust steam just equals the demand of consumers there is large profit in the work; but the periods when the exhaust steam is not sufficient must be considered. It is often necessary to run an independent engine to supply live steam to meet the requirements on very cold days or in the early winter evenings. The electric lighting is essentially a night load, but the highest peak is reached early in the evening or late in the afternoon of winter days. This is likewise the period when the greatest demand exists for steam for heating. It is often impossible to supply the two with the engines of the central station installed simply for the lighting load. The important question is to ascertain just when the conditions will warrant the enlargement of the plant by adding an independent engine for carrying the extra load. This engine may not be needed more than four or five months in the year, and the long period of its idleness must detract greatly from its value as a money-making machine.

A great many electric light companies operating by water power have installed engines for distributing steam heat to the different parts of the buildings of the plant. Such engines are used at times to carry part of the electric lighting load, but as a rule the engines are not in use a good part of the year. Where the plant is a large one this extra engine is found profitable, and in some cases it has been used for supplying district steam heating for other buildings in order to prevent rivals from entering the field. Where a neighboring plant or large building installs its own steam heating plant, it is very apt to furnish its own light as well. By anticipating this the electric companies have shut off private competition in electric light.

Indeed, it looks very much as if the electric companies must come to adopting this double work, so popular is steam heating becoming. The large office buildings and plants which depend upon electric light and power consider seriously the question of operating their own electric light and heating plant. The problem is only half solved when electric light and power are sold to them at a minimum of cost. The heating of the building must come up for serious attention. By supplying both electricity and steam heating to its customers, the electric light and power company gives added satisfaction and secures double returns on the investment.

While a central station plant can earn money out of exhaust steam for heating residences and offices in winter, the question of utilizing the power in the summer months has caused not a little bother and a good deal of practical experiment. With the day load in summer very light, the power of the engine should be utilized in some other economical way. A number of small central station plants supplying electric light for public and private use have in the past few years sought to extend their field by combining steam heating in winter and the operation of refrigerating and ice manufacturing plants in summer. Ice making and artificial refrigeration are summer loads, and the steam from the boilers which are used as auxiliaries in winter can be turned to profitable use in operating ice machines in the hot months. By combining the two industries the engines need be left idle only a very little of the time. The possibilities in this direction are not so limited as they may appear. A good many cold storage plants are operated only in the warm season, usually about four to six months in the year. The work of supplying steam for distilled water and for manufacturing ice or artificial refrigeration is sometimes problematical, for the cost of live steam furnished from boilers that are left idle most of the year is very high.

An electric light plant in Rochester which used exhaust steam for heating residences in winter enlarged its capacity by the installation of two extra boilers which furnished live steam when the demand was unusually heavy. Ultimately it was expected that the new boilers would be needed for the electric light business as the business increased, but until needed for that purpose the boilers were employed for furnishing live steam to customers for heating. The profits of this feature of the business proved so large that it was necessary to make another addition to the plant.

The question of utilizing these boilers in summer puzzled the engineers and managers for some time. The idleness a good part of the year seemed like waste. The managers tried to make arrangements to operate cold storage plants with their live steam, but owing to its peculiar location this seemed impossible. After a good deal of experiment and study it was decided to start a small ice-making plant near the central station. This was experimental, and the venture was carried on a small scale. But after one season's operation the success of the plant was evident. The ice was sold by contract to a local ice distributor, and the extra boilers were kept in profitable service all the year. No attempt was made to manufacture ice in winter, for the steam was then all needed for heating purposes.

Another electric light plant at Columbus, Ohio, has sought to combine refrigeration and steam heating in another way to utilize exhaust steam at the central station. Underground anhydrous ammonia and brine pipes were laid in such a way that in the winter time they could be used for supplying steam for heating purposes. So far this experiment has indicated success, but the question of general depreciation of the underground lines when used in this double capacity is one that cannot be answered immediately. There appears, however, a new field for development by which central stations can make use of their exhaust and surplus live steam by the combination of steam heating and refrigeration. As every factor that saves money must be considered it is quite important that careful attention should be given to these new fields.

ENGINE FRICTION AND LUBRICANTS.

BY R. T. STROHM.

The available power of a steam engine is the difference between the indicated horse-power and the friction horse-power. Consequently, to increase the delivered horse-power without correspondingly increasing the indicated horse-power, it is necessary to reduce the friction in the engine. This friction will exist wherever two surfaces come into sliding contact, and the amount of friction will depend altogether upon the condition of the rubbing surfaces and the pressure with which they bear against one another.

In the ordinary engine the main points at which frictional resistances occur are at the main shaft bearings, at the crank-pin, at the cross-head pin, along the guides, in the stuffing-boxes of the piston rod and valve stem, between the eccentric strap and its sheave, between the valve and its seat, and between the piston and the cylinder. There will be friction at the numerous smaller pins and in the governor connections, as well as wind resistance to the motion of the fly-wheel, but these latter may be neglected in view of the major points already mentioned.

In order to devise means whereby friction may be reduced, it is essential that its nature, cause and effect be understood. As to its nature, it is simply a resistance to

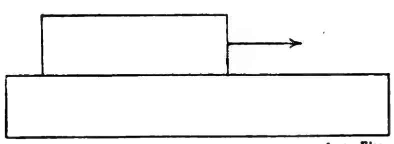


FIG. 1.

the motion of one body in contact with another. It is caused by irregularities in the rubbing surfaces. Take, for example, two cast-iron blocks having their contiguous faces planed and scraped accurately so as to be as nearly true planes as possible. If these blocks be placed as in Fig. 1 and the upper one be drawn across the lower, it will be found that there is considerable resistance to the motion, in spite of the fact that the surfaces had been made as flat and smooth as mechanical art would permit. This resistance is due to friction, and it is evident that even extreme precautions in preparing the rubbing surfaces have not sufficed to eliminate friction.

If, now, the blocks in Fig. 1 were cut lengthwise in a plane at right angles to the surfaces in contact, and the line of contact of the two surfaces thus exposed were viewed through a powerful microscope, it would appear somewhat as shown in Fig. 2. That is, instead of showing as a straight line, indicating perfect contact of both surfaces at every point, it would appear as two very irregular lines touching at various points, indicating that the surfaces are full of minute hills and hollows.

The cause of the resistance to motion of one block upon the other now becomes apparent. Many of the small projections or hills on one block fit into the depressions or hollows in the other, so that when the upper one is moved these ridges interlock, and thus resist the moving force.

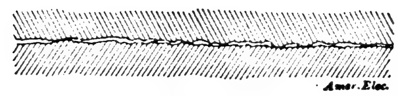


FIG. 2.

If these indentations are deep and the number of projections which fit into them are sufficiently great, the resistance offered may be sufficient to prevent any relative motion. Usually, however, the reverse occurs; that is, one block slides upon the other and the ridges are torn loose from their respective surfaces, this action being accompanied by the generation of heat.

The effect of friction, then, is threefold. First, it causes a resistance. Second, it wears and abrades the touching surfaces. Third, it causes the generation of heat. In the case of the steam engine, all three effects are undesirable. The resistance decreases the useful output of the engine, as has already been shown. The wear due to abrasion requires tightening of the brasses or packing and shortens the life of the engine. The heat generated may become of sufficient amount as to cause the brasses to grip or seize the pin, may melt out babbitt bearings, or harden packing so as to cause it to score the rod. Hence, the extreme desirability of reducing friction to a minimum.

Friction is reduced by the use of lubricants which may be divided into three general classes, known as fluid, plastic and solid lubricants. The first class includes all oils. The second class comprises the greases. The last class includes such solids as have been used for lubricating.

The theory of the action of a lubricant is very simple. In connection with Fig. 2 it was shown that frictional resistance is due to the interlocking of the ridges on the rubbing surfaces. The lubricant prevents this interlocking by filling up all the hollows and forming a very thin layer between the two surfaces, so that they touch only at very few points, where the ridges are higher than the average. For perfect lubrication, the lubricant should form a film between the surfaces that will prevent any contact whatever. But this is a condition scarcely realizable in practice. There will always be more or less contact of the surfaces, resulting in a corresponding degree of wear.

Applying these statements to the steam engine, it is evident that the first requirement for the reduction of friction losses is the selection of proper lubricants, and the second is the proper application of these lubricants to the rubbing surfaces. Inasmuch as the subject of cylinder and valve lubrication is so extensive and important as to warrant treatment in a separate article, lubricants for engine bearings alone will be considered here.

Much has been written concerning the selection of lubricants for given conditions. It is rarely the case that the selection of the best lubricant can be made off-hand. By far the most satisfactory method is to try various lubricants until one is found which gives good results, and this grade should then be demanded for future use. Nevertheless, there are a few fundamental rules governing the selection of a lubricant by which it is possible to narrow the field for any given set of conditions to a single class of lubricants.

For small engines in which the pressure on the bearings is comparatively light and the speed fairly high, a light mineral oil will be found to answer the purpose. For heavy pressure and high speed a heavy mineral oil should be used. If the pressure is heavy and the speed comparatively slow, then a very heavy oil, or a grease, should be employed. For ordinary machinery having no excessive bearing pressures, a fairly heavy mineral oil is generally used.

To be of value, a lubricant must contain no grit of any character. The presence of foreign matter of this nature will cause cutting of the bearing and of the journal, and will result in heating and probable seizure of the bearing. The test for grit particles is not elaborate. If a drop of oil or a bit of grease be well rubbed between the thumb and forefinger, or between the palm of one hand and the finger of the other, the presence of gritty matter may be readily detected.

Very often dirt will get into oil through carelessness. For the engineer to be certain, therefore, that the oil in his tank is clear and free from dirt, he should see that each new supply of oil, upon being emptied into the reservoir, is strained. The apparatus necessary is very simple and of trifling cost, and may save future trouble with hot bearings.

Since it is the function of a lubricant to form a layer or film between two surfaces so as to hold those surfaces apart, it follows that in order to do this successfully the lubricant must have body or cohesion enough to prevent its being squeezed out by the pressure. A very thin lubricant is, therefore, used where pressures are extremely light, and a very thick one where pressures are extremely heavy.

Now, it is plain that if the lubricant fills the depressions in the journal and in the bearing, and the former turns while the latter remains stationary, the particles nearest the journal will move at a velocity corresponding to that of the journal, while those nearest the bearing will be practically at rest. Slipping must occur, then, somewhere between the two surfaces. In ideal lubrication, all slipping occurs between the particles of lubricant which form the film, although actually there is some contact of metal and metal. In a bearing, then, there is some friction due to the rubbing metals and some due to the rubbing of the oil particles. The latter may be termed fluid friction, and it is much less in the case of a thin oil than in the case of a heavy, viscous one, while it always forms by far the smallest percentage of the total friction in a bearing. It is, therefore, advantageous to use a lubricant no more viscous than is absolutely necessary to prevent its being forced out from between the surfaces. Oth-

erwise, there will be unnecessary loss of power due to extra fluid friction.

Again, the lubricant used must not be volatile, that is, too easily vaporized under the effects of heat. If this should be the case, there would be danger of its becoming so thin when warmed by the friction of the bearing, that it could be forced out by the pressure. At the same time, rapid evaporation would increase the oil consumption without rendering any additional service in friction reduction. On the other hand, ordinary degrees of coldness ought not to thicken the oil appreciably. This is a thing that will happen if the oil contains paraffin to give it body.

The lubricant must also be free of all tendency to dry and become gummy. Should it possess any such properties, the probability is that the oil holes in the oil cups, the channels in the bearings, and the very film itself, would become clogged, under which conditions no oil could be fed to the bearing. A lubricant may readily be tested as to its tendency to gum, by putting a few drops on a clean piece of glass and allowing the whole to stand exposed to the air for some time.

Oils used as lubricants are derived from three sources. First, from the distillation of crude petroleum, such being known as mineral oils because of their mineral origin. Second, from the fatty tissues of various animals, these being known as animal oils. Lard oil, sperm oil and tallow oil are examples of this class. Third, from the nuts or seeds of various trees or shrubs, such oils being termed vegetable oils, because of their vegetable origin. As examples of this class may be mentioned olive oil, palm oil and castor oil.

For the lubrication of general machinery, mineral oils and animal oils hold the field, the vegetable oils being employed less rarely. In steam engine lubrication, mineral oils are used almost exclusively, though in some cases a compound lubricant is made by mixing a small percentage of animal oil with mineral oil. The disadvantage of animal and vegetable oils is that they are subject to decomposition under the effects of heat, with the liberation of acids which will attack metals and cause corrosion. Consequently, it is advisable to use straight mineral oils wherever possible, since they cannot decompose, and contain no injurious acids.

Under the heading of plastic lubricants come the various kinds of greases. These are usually made by mixing oils and fats in various proportions until the mixture has the consistency of lard. However, for engine lubrication, a grease must not be selected indiscriminately. Those greases which are mere mechanical mixtures of cheap oil, paraffin and fatty oils have a high friction coefficient in themselves and are corrosive when decomposed. The proper kind of grease to use on engine bearings is that which is produced by chemical combination of oils and fats. These have no chemical action on metals used for bearings, and will not become rancid or spoil, even though they are kept for a long time.

The solid lubricants are graphite, mica, sulphur and soapstone. All of these have been used in the lubrication of engines, but the first is by far the most common of the four. It is not to be supposed, either, that these solid lubricants are to be used alone on a bearing. The best results are obtained by using them in conjunction with oil. The mixing of graphite, soapstone, mica or sulphur with oil forms a lubricant which is found to be of inestimable service in cases where a pin or bearing has run hot, since it enables the engine to be kept in motion and at the same time reduces the temperature of the bearing. When it is remembered that a complete shutdown of an engine in a plant, for a sufficient length of time to cool and readjust a bearing, may mean a loss running into hundreds and thousands of dollars, the value of a lubricant which will permit continued service without ill effects, becomes apparent.

The action of graphite as a lubricant in connection with oil is peculiar. Being a solid, it becomes pressed into the irregularities of each surface, and thus brings each nearer to a condition of perfect smoothness. Consequently, the oil film between the surfaces need not be so thick. And, since it requires a greater pressure to squeeze out a thin film than a thick one, a less viscous oil may be used, resulting in a smaller amount of fluid friction.

The amount of oil may also be reduced, since the graphite fills up all the cuts and scratches and forms an exceedingly smooth glaze on each surface, possessing a low friction coefficient.

The solid lubricants mentioned are mineral in their nature, and care must be observed to obtain them in a pure state, free from earth or grit of any character which would cause unnecessary friction, heating and abrasion.

ELECTRICAL EQUIPMENT OF THE KEYSER VALLEY SHOPS OF THE LACKAWANNA RAILROAD.

The Keyser Valley shops of the Lackawanna Railroad, situated in Keyser Valley near Scranton, Pa., have been designed to take care of the freight equipment, including all repairs and upkeep on both wood and steel cars, and are fitted to do new work also on an extensive scale. The plant, which has recently been placed in operation, ranks among the most complete and up-to-date railroad shops in the country. The buildings are equipped throughout with motor-driven tools and labor-saving appliances and are provided with an abundance of natural and artificial light.

The plant comprises nine large buildings of brick and steel construction. The area covered by the buildings aggregates six acres, while the total floor space aggregates 225,000 square feet, of which 217,500 square feet are in cement. The entire electrical equipment of the shops is of General Electric make. In the power house are one 100-kw. and two 300-kw., three-phase, 60-cycle, 480-volt generators; each of which is direct-connected to a Ball & Wood engine. There are in addition one 30-kw. steam-driven exciter unit and a motor-driven ex-

TABLE II.—MOTOR DRIVES IN MACHINE SHOP.

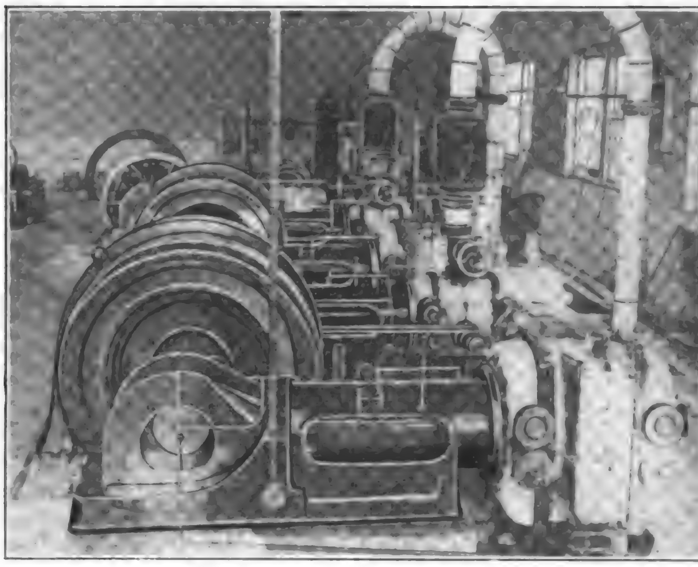
Tool.	Pulley, Inches.	Belt, Inches.	R.P.M.	Method of Drive.	H.P., Computed.	H.P., Motor.
Hydraulic wheel press for pressing off	24	8	172	Group	9.98	5
Hydraulic wheel press for pressing on	24	8	172	"	9.98	5
Niles boring mill for car wheels	16	5	90	"	1.98	3
Boring mill for wheels	22	5	135	"	3.94	7½
Wheel boring mill	16	4	135	"	2.38	3
Axle cent. machine	9	4	233	"	3.00	3
Lathe for 36-inch steel tired wheels	18	5	90	"	2.23	7½
Emery grinder	6¼	3	1,100	"	5.97	2
Small lathe, 7-inch swing	5¼	2	540	"	1.56	1
Gang drill	20	3½	175	"	3.37	7½
Axle lathe, single head	17	4	150	"	2.81	5
Double headed axle lathe	26	5	194	"	6.5	10
Fox lathe, 7-inch swing	3½	1¼	557	"	.93	1
Drill	12	2½	250	"	2.66	3
Barnes drill	10	3	262	"	2.16	3
Pond lathe, 30-inch swing	17¼	3½	65	"	1.81	5
Double headed shaper	18	3½	120	"	2.83	6
Prentice drill	12	3	220	"	2.13	2
Long lathe, 15-foot	12	2½	20	.....	...	3
Bement drill press, No. 757	8	2½	246	Group	1.35	2
Small lathe, 10-foot	8	2½	100	.....	...	2
Planer, 36-inch	28	5	170	Group	6.50	10
Pipe cutter	12	3½	200	"	2.31	2
Twist drill grinder	3	1½	1,665	"	2.64	¼
Small bench drill	6	2	208	"	.70	1
Grind for mine car seats	4	2½	1,600	"	4.10	2
D. H. bolt cutter, 1-foot 2-inch	12¼	3	229	"	2.31	3
Double bolt cutter	12¼	3	229	"	2.31	3
Double bolt cutter	12¼	3	229	"	2.31	3
Double bolt cutter	12¼	3	229	"	2.31	3
Double bolt cutter	12¼	3	190	"	1.96	3
18-foot lathe, 24-inch	..	..	...	"	....	3
Large drill	..	..	...	Individual	...	5
Two-spindle bolt cutter	12½	3	190	Group	1.96	5
Nut tapping machine, large	16	4	175	"	3.99	5
Nut tapping machine, small	16	4	175	"	3.99	3
13-inch tool room lathe	14¾	2½	610	"	.62	3
Grinding machine	8	4	656	"	5.78	5
Grindstone	..	..	...	"	...	1
Double bolt cutter	12	3	229	"	2.31	1
New lathe, 20-inch	..	..	...	"	...	3
Slotter	16	2½	75	"	81	3
Milling machine, Universal	..	..	...	"	...	3
Dish hole tool grinder	..	..	...	"	...	1
Double head axle lathe	26	5¼	194	"	7.99	7½
Double head axle lathe	26	5¼	194	"	7.99	7½
Drill in tool room	..	..	...	"	...	¼
Small drill (in B.S. shop)	14	3½	200	"	2.70	3
Large drill (in B.S. shop)	..	..	...	Individual	...	5
Hydraulic press (Schafer)	..	..	...	Group	...	5
Gang drill, 8 spindles	..	..	...	"	...	7½

citer unit, also of 30 kilowatts capacity.

Steam is supplied by Stirling water-tube boilers and a complete motor-driven coal and ash-handling system is installed. Electricity is transmitted from the power house to the shops by lead-covered cables which are placed in underground terra-cotta ducts. Suitable distribution panels, to which the supply mains and motor and lighting feeders are brought, are placed in each building. By this means a great number of

TABLE IV.—LIGHTING SCHEME.

Building.	Dimensions. Feet.	Area.	No. of Arc Lamps.	Approx. spacing of Arc Lamps. Feet.	No. of Incand. Lamps 4 C.P.	No. of Incand. Lamps 16 C.P.	Total Kw.	Total Watts per Sq. Ft.
Repair Shop No. 1	150 x 400	60,000	60	33	..	..	32.4	.54
Repair Shop No. 2	150 x 400	60,000	60	33	..	..	32.4	.54
Paint Shop	60 x 400	24,000	26	32	..	45	16.74	.7
Annex	20 x 280	5,600	..	..	..	75	4.5	.8
Planing Mill	90 x 400	36,000	23	40	30	..	13.	.36
Machine Shop	80 x 180	14,400	16	26	15	..	18.93	.62
Blacksmith Shop	80 x 300	24,000	12	40	..	..	6.48	.27
Power House	50 x 180	9,000	4	35	..	10	2.76	.31
Office and Storehouse......	44 x 105	4,620	..	..	..	50	3.00	.65



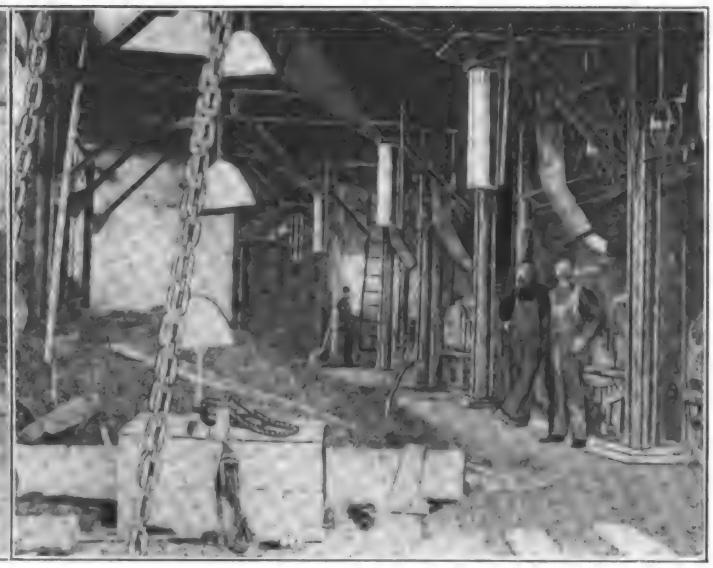


FIG. 1.—VIEWS OF ENGINE AND BOILER ROOMS TAKEN PRIOR TO THEIR COMPLETION.—FIG. 2.

TABLE 1.—MOTOR DRIVES IN SMITH SHOP.

Tool.	Pulley, Inches.	Belt, Inches.	R.P.M.	Method of Drive.	H.P., Computed.	H.P., Motor.
Punch and shear	36	4½	240	Group	3	3.0
Belt hammer	18	5	310	"	7.6	5.0
Punch and shear...............................	30	5½	180	"	8.2	15.0
Bolt header, 1-inch............................	46	6	90 to 100	"	5	5.0
Alligator shears	18	7½	200	"	7.5	5.0
Bulldozer	36	6	450	Individual	26	15.0
Belt hammer	18	5	310	Group	7.6	5.0
Blakeslee bolt header....................	40	8	200	"	17.7	10.0
Punch and shear, new.........................	..	..	...	Individual	20	20.0
Bolt header, 1-inch bolts......................	35½	5½	100	Group	5	5.0
Forging machine, 2½-inch	40	10	225	"	24.7	10.0
Eye bending machine	20	2	280	"	5	5.0
Jointer	..	..	...	.....	0.5	.5
Bulldozer	30	10	240	Group	7.5	7.5
Small punch	15	8	93	"	5	5.0

Aggregate computed H.P., 150.3.
Corresponding aggregate in H.P. of motors in stalled, 116.

lighting and power circuit combinations are available to meet changes in the arrangement of tools, etc. The wiring is carried in various-sized loricated metal tubes laid in the cement floors. Fig. 4 shows the method of carrying the wires in conduit to the motors. The various motor drives installed at the shops are given in the accompanying tables. Four hundred and forty-volt induction motors are used exclusively. The figures in the heading "horse-power computed" are obtained by the formula:

H. P. = speed of belt in feet per minute × width of belt in inches ÷ 950.

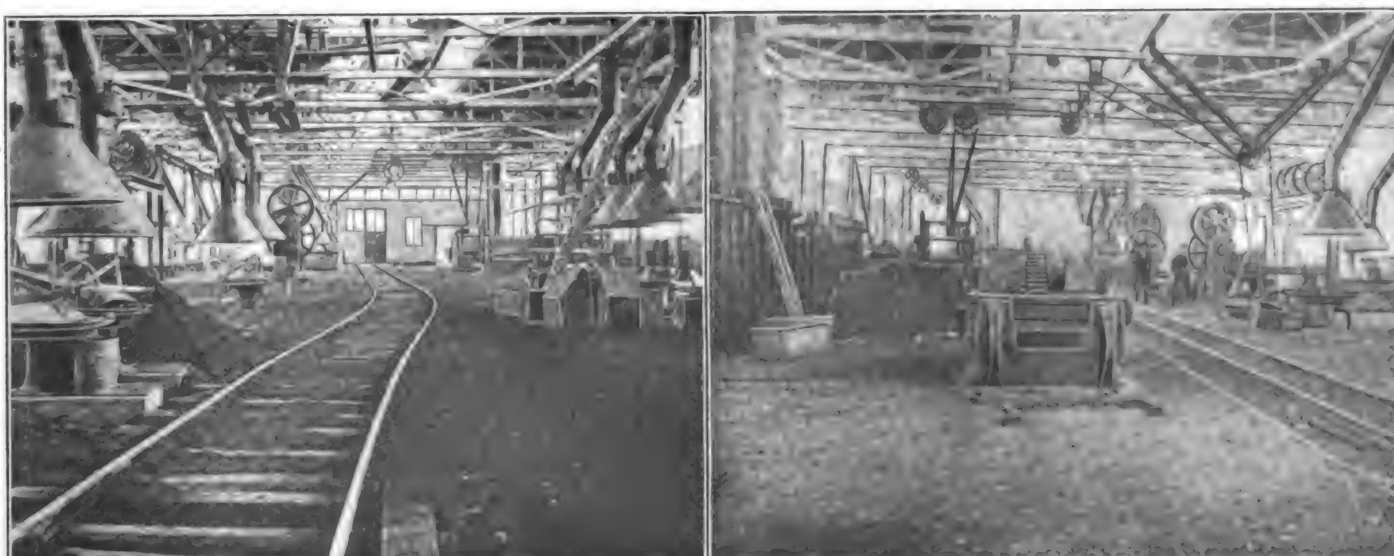


FIG. 3.—VIEWS OF BLACKSMITH SHOP.

With the exception of one gear drive, the individual drives are all belt-connected, and

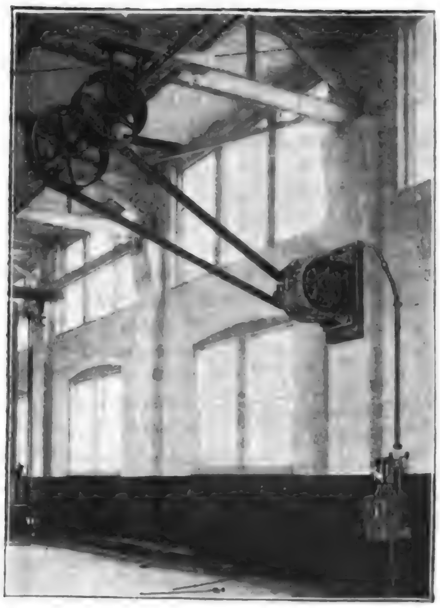


FIG. 4.—MOTOR APPLICATION, D., L. & W. R. R. SHOPS.

the group drives are similarly connected with the exception of two chain drives. Figs. 4 and 5 show various methods of installing the motors in out-of-the-way

TABLE III.—MOTOR DRIVES IN PLANING MILL.

Tool.	Pulley, Inches.	Belt, Inches.	R.P.M.	Method of Drive.	H.P., Computed.	H.P., Motor.
Double planer and matcher	16	8	854	Individual	29.60	30
Swing saw, 30-inch	6	4	1,600	"	10.68	10
Rip saw, up to 24-inch	6	5	1,700	"	13.60	15
Double planer, with matcher	14	8	920	"	31.13	30
Six-inch outside moulder	8½	4¾	800	Group	8.88	10
Cross-cut saw, 40-inch	16	7	575	"	17.71	15
Sill tenoner	12	8	500	"	13.24	10
Cross boring machine	8	3	785	"	5.18	3
Boring machine, 4 spindles	14	8	343	"	9.80	7½
Ver. car boring machine, 3 spindles	10	5	350	"	4.75	5
Rip saw	6½	5	1,600	Individual	14.40	20
Automatic cross-cut saw, 36-inch	14	8	600	"	15.00	15
Rip saw, 24-inch	12	5½	458	Group	7.48	15
Sticker, 5-head	12	8	750	"	19.42	20
Upright shaping machine	8¾	4¾	720	"	8.61	7½
Matcher	12	7½	900	Individual	21.75	20
Gaining machine	14	8	325	Group	10.00	10
Gaining machine	12	6	730	"	13.46	10
Hollow chisel, hollow mortiser	14	6	750	"	8.40	15
Three-spindle boring, machine	12	3½	400	"	4.53	5
Wood turning lathe	9½	2½	250	"	1.63	2
Wood turning lathe	9½	2	360	"	1.88	2
Saw grinding and sharpening machine	5	2	540	"	1.42	2
Automatic knife grinder	10	2½	360	"	2.47	2
Band saw filer, scrapped	10	1¾	45	"	.22	1
Band saw, 36-inch	12	4	500	"	6.60	7½
Swing saw, 22-inch	10	5	550	"	8.72	7½
Hard planer	4	4	3,500	"	15.39	10
Door and sash tenoning machine	10	4	880	"	9.70	10
Extra heavy 6-roll sizer, 4 sides	16	12	1,000	Individual	52.90	50
Flooring machine, fast speed	16	9	900	"	37.11	30
Double cutting-off machine	16	10	450	Group	19.84	25
Ver. car boring machine, 4 spindles	16	8	375	"	11.12	10
Same with Universal attachment	16	8	375	"	13.22	7½
Heavy self-feed saw	12	8	900	Individual	22.34	20
Combination ver. borer and gainer	18	10	540	"	26.78	15
Small ver. hollow chisel mortiser	10	5	900	Group	12.40	7½
Hollow chisel mortiser	14	8	700	"	22.02	20
Ver. car tenoning machine	8	8	1,800	"	31.21	20
Double tenoning machine	18	10	900	Individual	44.64	40
Car brace cutting-off machine	10	8	900	Group	14.57	7½
Cross-cut saw	12	5	665	...	10.90	10
Wood turning lathe	9½	2½	150	Group	1.59	3
Cut-off saw, 22-inch	10	6	700	"	9.64	7½
Groove saw, 12-inch	..	..	...	"	10.00	10
Box board matcher	..	..	...	"	5.00	5
Grindstone	24	5½	50	"	1.81	2
Heavy combined buzz planer	12	6	1,000	Individual	19.84	20
Hollow chisel sharpener	3	2	3,000	Group	4.95	1
Band resawing machine	20	6	480	"	16.92	7
Sharpener for circular saw	10	2	480	"	2.29	1
Band saw filing and setting machine	10	1½	50	"	.20	1
Lathe	3½	2	2,000	"	3.42	2
Rip saw	12	6	458	"	9.03	5
Jig saw	8	3	675	"	4.45	3
Single surface	5	4	3,000	"	16.55	15
Band saw	12	3½	450	"	5.20	5
Emery grinder and dust guard machine	7	2¾	642	"	3.40	1
Mortiser	10	3	300	"	2.50	2
Shaper	10	4	750	"	8.26	5
Knife grinder	5	3½	900	"	4.46	5

Aggregate computed HP., 764.11.
Corresponding aggregate in H. P. of motors installed, 670.

places. In addition to the tabulated equipment, motor-driven fans are installed for the heating system of the plant and for exhausting shavings from the planing mill,

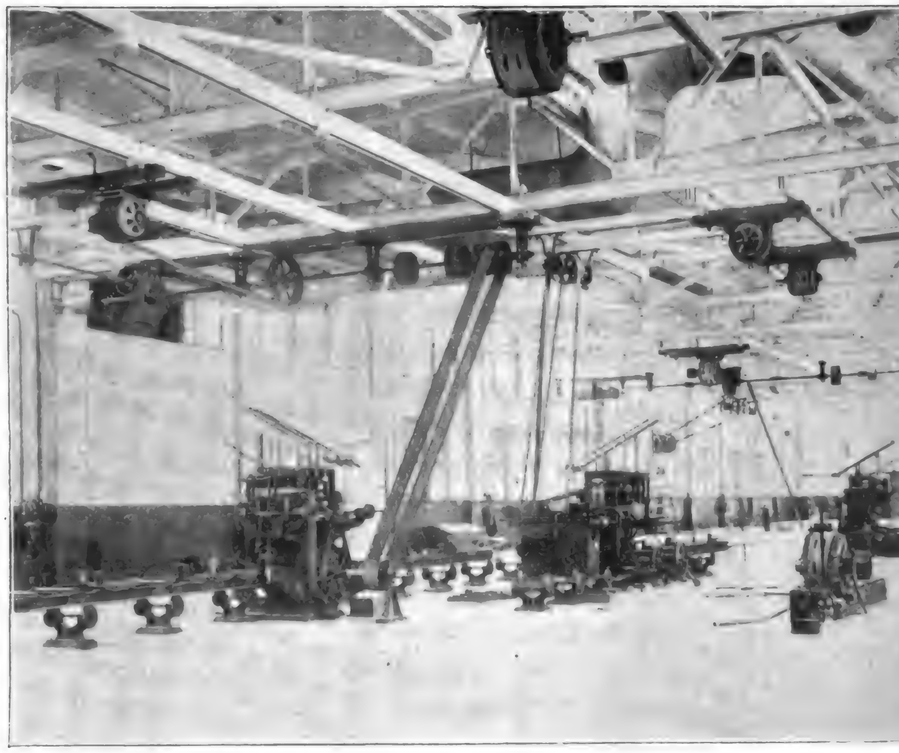


FIG. 5.—MOTOR APPLICATIONS IN PLANING MILL.

and motor-driven blowers are installed in the smith shop.

The lighting scheme for the various shops is presented in Table 4. In cases where arc lamps are staggered, the diagonal distance between lamps is given. Two hundred and one arc lamps were originally installed for indoor lighting, and these are all fitted with concentric diffusers. Thirty arc lamps are used for outdoor lighting. Of the total number of arc lamps now in use the majority are of the multiple type. Series arc lamps, supplied from constant-current transformers, are used for all-night lighting of the buildings and grounds. It is believed that this distribution of arc and incandescent lamps makes the Keyser Valley plant one of the best lighted railroad repair shops in the country.

REINFORCED CONCRETE POLES FOR TRANSMISSION LINES.

Experiments are being made on some of the Canadian transmission systems with reinforced concretes poles. The cedar poles heretofore used are becoming scarce, inferior in quality and high in price. In addition cedar poles require to be set closely together where heavy wires are carried, and this means large numbers of cross-arms and insulators. Steel poles have been used in some places to carry spans 400 feet long; but these are expensive and require some care in their maintenance. Wide base steel towers have also been erected where the right of way is large enough to admit of their use. On the Welland Canal transmission line, poles of reinforced concrete are used at railway and road crossings where extra high poles are required.

The poles are manufactured on the ground as it has been found very expensive to transport them on account of their great weight; a 35-foot pole for ordinary line work weighing about two and one-half tons, and a 50-foot one about five tons.

Most of the poles so far made have been calculated to stand a horizontal pull at the top of 2,000 pounds, and tests that have been made show that the calculations have been correct, all standing the full load without any impairment, except one, which failed at 2,025 pounds, the cause being a flaw in the weld on one of the steel rods.

All poles have been made square, with the corners champered off, on account of ease in making and also on account of the saving in steel over any other section. The poles are molded in wooden forms, in a horizontal position, the top side being left open and finished with a trowel. Foot steps are imbedded in the soft concrete as the pole is being made and bolts for cross-arms also, or holes are left so that a bolt may afterwards be put right through the pole. The concrete is composed of 1 part best Portland cement, 2 parts clean sharp sand and 4 parts of finely broken stone; although gravel has been used with success. The poles are quite elastic. They do not require painting, being of a pleasing gray color, and it is claimed are not affected by the weather. Two 150-foot cement poles will shortly be erected at St. Catherine's to carry wires over the old Welland Canal for the Lincoln Electric Light & Power Company.

The cost of the concrete poles depends on local conditions and the specifications regarding material and strength. It is stated that, as a general rule, the cost is 25 per cent. less than that of a steel pole of similar strength. They present a better appearance than these latter, and do not rust at the ground line.

WINDOW LIGHTING.

BY E. R. ROBERTS.

To the central station manager who is anxious to improve his load factor, the lighting of store windows would seem to be a very attractive field. The central station manager has for some time appreciated the benefit which accrues to him as well as to the customer through the sale of electric current for advertising in the form of electric signs; yet the field of window lighting, which should prove fully as lucrative, lies in a state of more or less neglect.

One cannot travel about the country, especially the smaller towns, without realizing more and more that such is the case, and that the art of window illumination as practised by many so-called enterprising merchants falls far short of what good practice demands.

Reviewing the situation one comes to the conclusion that the cause of this state of affairs is a lack of co-operation between the merchant and the light man, with the result that the window installation is off duty during the period when both parties need it the most.

During the rush of business hours people have no time to stop and view window displays. That pastime is reserved for the evening stroll after dinner, when business worries have been put aside for the day, and people are actually on the lookout for something to claim their interest. Needless to say, a dismal, poorly lighted business street at night repels about as many pleasure seekers and strollers in search of recreation as a brightly lighted thoroughfare attracts.

The advertising value of well illuminated store windows during the evening hours after business has ceased, is not a theory, but a substantiated fact, which any up-to-date merchant will appreciate and be eager to take advantage of just as soon as the electric lighting company meets him half way with a reasonable proposition. The merchant has the incentive, but awaits the inducement. Meanwhile, he continues to throw off his window switch at closing time.

The central station manager no doubt appreciates the value of the long-hour customer, and goes after every drug store, saloon or restaurant in sight. The owner of show windows is no less desirable as a customer, and it is to the lighting company's advantage to make a rate for window lighting during the evening hours which will be well nigh irresistible to a progressive merchant.

Window lighting service is needed continuously during a definite period of each day. It is more or less isolated and free from interference, and is much the same as electric sign service. Consequently, the flat rate system of charging is especially applicable, and has its strong advocates. In any case, whether the meter or flat rate be employed, the problem of shutting off the light at midnight, or earlier if desired, is easily solved by the use of an automatic time switch, which may be sold or rented to the customer.

In a window lighting campaign the electric light company should not only establish an attractive charging rate, but it should lend its influence toward the more intelligent use of electric light as a means to an end, thereby bringing to the attention of its prospective customers the advantages of electric service, while at the same time winning the confidence and respect of its patrons.

As in all other forms of lighting, except sign work, in the installation of window lamps it is too often forgotten that illumination, and not mere light, is the object sought. Many a fine window display is greatly weakened by the harsh, spectacular, and even blinding effect of unshielded border lamps, and possibly one-third the amount of energy delivered to the concealed reflector lamps would greatly enhance the value of the illumination.

Another point which demands careful consideration in window illumination is the color or quality of the light provided. It is a well known fact that colored goods and wares are only seen in their natural hues when viewed by natural light, and that the various tints are materially altered by the use of artificial light of different qualities, a notable example of this being the effect on colors produced by the mercury vapor lamp. Since the window space of a store is set apart solely for the purpose of attracting buyers it is evident that a light of suitable quality is of even greater importance here, than it is in the store itself.

The incandescent lamp by virtue of its neat, compact structure in comparison with the bulky arc lamp, and its numerous advantages over the Welsbach gas lamp, has grown very popular in the field of window lighting; yet, in the orange color of the incandescent light there is still much to be desired. The efficient Nernst lamp with its softer and whiter light is particularly applicable in this field where alternating-current is available.

THE POWER STATION.

BY FRED N. BUSHNELL.

Since the advent of the direct-connected generator, the tendency in power-station design has been toward a more systematic and compact organization of the generating apparatus and the utmost simplicity of the entire plant consistent with the highest efficiency. The practice of different engineers has gradually worked toward a type of station which is now so generally adopted for street railway work where limitations are not placed upon the design by the size or shape of the available site, that it can fairly be said to represent standard practice in modern power station engineering. It embodies the following essential principles:

1. Simplicity of design.
2. Sub-division of the plant into separate sections, so as to localize the effect of trouble to any part of the generating apparatus.
3. Provision for the symmetrical extension of the plant to provide for future power requirements.

This station in its simplest form consists of a boiler room, engine and generator room, and switchboard gallery, arranged in parallel lines and separated from each other by substantial fireproof walls. In stations of very large size the boilers are frequently arranged in two tiers, or in groups, each group having its own chimney and flues and independent systems of feed and steam piping. This arrangement of the station is now generally referred to as the unit system, the distinguishing feature of which is that the boilers, engines and generating apparatus are arranged in separate units or groups, each one of which embodies all of the essential features of a complete generating plant, and the great advantage of which lies in the fact that trouble with any single piece of apparatus is localized, so that its effect is felt only in that unit of which it forms a part. Provision for carrying the load in the event of a breakdown of any important part of the apparatus is made by installing an additional or spare unit.

While the unit system is now almost universally employed in the larger power stations, it is usually somewhat modified for smaller plants where the liability to interruption of the service is not so great or the results so disastrous, the chief difference being in the arrangement of the steam and

feed piping. The steam piping from the boilers is run to a longitudinal header, from which the connections to the engines are taken off at convenient points. This steam header is divided into sections by means of gate valves, which permit of any section being cut out at the convenience of the operator for the purpose of making repairs. Usually two systems of feed piping are provided, one of which supplies hot water to the boilers through the heaters and economizers, while the second, or auxiliary system, supplies cold water, or water direct from the heaters, in case of trouble with the main system. This arrangement of piping provides sufficiently against interruption in small and medium-sized plants, and in a system carefuly laid out with due consideration for the troubles which are likely to arise, it is hardly probable that the disarrangement of any one part will cause serious interruption of the service.

At the present time alternating-current generating stations and distributing systems are regarded as the most efficient to install in large cities where heavy traffic is distributed over a very large area, requiring current to be delivered to the line at a number of points, and where the interest upon the investment in direct-current feeders and cost of their maintenance would amount to more than the same charges plus the conversion losses in an alternating-current system; and for long suburban or interurban railways where the power required at any one point is small as compared with the total power generated. The use of alternating-current apparatus has steadily increased since its introduction, until at the present time approximately 60 per cent. of the total power used by electric railways in the United States is generated by this type of apparatus.

In cities where the bulk of the business is within the economical radius of distribution for direct-current lines, and where direct-current generators form the larger part of the present equipment, the common solution of the problem is to use this type of apparatus for city work, adding alternating-current apparatus to supply the more distant portions of the system, or roads operating through outlying districts.

There is undoubtedly a great advantage in having all the apparatus of a uniform type. This simplifies the wiring and switching part of the electrical equipment, and permits of a more efficient distribution of the load in the station. But there can be no conversion of energy without loss, and in cases where a considerable part of the system can be supplied with direct current without the use of rotary converters, the composite type of station will frequently be found to offer advantages in lower first cost and higher efficiency.

The location of the power station, its general character, and the type of apparatus to be installed, depend to such an extent upon local conditions, that it is difficult to offer suggestions covering these points except in a general way.

If possible, the station should be located near an ample supply of water for condensing purposes, in order to secure the advantages from the use of the most efficient types of steam apparatus, and if possible, convenient also to a steam railroad or tide water, where the coal can be received and handled for the least expenditure of labor. Its location in reference to the distributing system will depend upon the extent and type of the system employed. If the direct-current system is used, it will be desirable to select a location as near as possible to its center of gravity, in order to reduce the investment in copper, but in the case of an alternating-current distributing system, this is of less importance, and greater consideration will be given to the cost of the available site, the nature of the soil, cost of foundations, etc.

The building should in all cases be of fireproof construction and of neat and attractive design, appropriate to and suggestive of the purpose for which it is used. In determining upon the dimensions of the building, it is important that ample room be provided for all of the apparatus to be installed, so as to avoid unnecessary crowding. Passageways should be provided between each battery of boilers, and at the rear for the convenience of attendants in cleaning the tubes and connections and for making necessary repairs. Sufficient room should also be provided around each piece of apparatus in the engine room, so as to enable the attendants to inspect it regularly and keep it thoroughly clean, and to provide for the removal of any part in case of repairs.

In large cities, where land is extremely valuable, or the available area limited, the amount of power which can be generated per unit of ground area occupied is frequently the controlling factor in deciding upon the power station plans, and in such cases it is not always practicable to provide all of the space usually regarded as desirable for the convenience of attendants. This condition rarely exists, however, except in the larger cities, and in a great majority of cases no excuse can be offered for crowding the machinery to such an extent that it cannot be kept in proper condition and conveniently repaired by those responsible for the management of the plant.

Cleanliness is absolutely essential to the successful operation of an electric railway power station. It is necessary that the building itself be kept free from oil and dirt, and each piece of apparatus thoroughly clean at all times, in order to maintain it in its highest state of efficiency. The designing engineer should contribute his share towards this result by providing ample light throughout the building—boiler room as well as engine or generator room. All the walls of the building should be painted in some light shade, preferably with some kind of enamel paint which can be easily washed down and kept clean. This will be found to reflect the light into dark corners of the building or spaces around the machinery, which might otherwise form receptacles for dirt and rubbish. It will add very much to the cleanliness and general appearance of the plant, and will contribute toward its successful running.

In designing a power station, the primary object in view is to deliver power at the bus-bars for the least expenditure of money, due importance, of course, being given to reliability of operation, which is the controlling principle in power station work. The fixed charges—interest, depreciation, insurance and taxes, should be as carefully considered as the cost of fuel, labor, supplies, repairs and other items which make up the operating expenses. Consideration should be given to each of these elements in proportion to its importance as a factor in the cost of power. In the great majority of cases fuel is the most important item of expense, frequently amounting to more than all other operating costs combined, and the perfection of these details of design and management which will effect the greatest economy in its use will usually make the best return for the time and labor expended.

Electrical apparatus has now been developed to such a state of perfection that in a well-designed and carefully managed power station over 90 per cent. of the power of the engines is converted into electrical energy and delivered to the transmission system for the operation of cars.. It appears, therefore, that no very great gain in coal economy is to be expected from the further improvement of electric generators or switching apparatus, and engineers are directing their efforts more than ever before to the steam portion of the power station, which offers a more promising field for a reduction in the cost of power.

The number and size of units to be installed is one of the most important problems bearing upon fuel economy which the engineer is called upon to solve. In order to obtain the maximum efficiency from the prime movers and their auxiliaries, it is necessary that they should be proportioned to the load they are intended to drive, so that if possible they may be operated at all times at or near their rated capacity.

In electric railway power stations it is not regarded as practicable to change the speed of the air or circulating pumps, or to alter the quantity of cooling water, to suit the varying loads upon the station, and these auxiliaries are usually operated at a point sufficient to take care of the maximum load. The power required to drive them is therefore practically constant, and their steam consumption per unit of output will vary indirectly as the load on the main engines. Under ordinary operating conditions, where the exhaust steam is used for heating the feed water, only about 12 per cent. of the heat in the total steam generated can be used for this purpose, and all steam used by the auxiliaries in excess of this must go to waste; and it follows that in addition to the losses due to the reduced efficiency of the prime movers at light loads, the percentage of loss in the auxiliaries will increase very rapidly as the load upon the main engine decreases, and the best economy of the entire plant will be obtained only when the engines are operated at or slightly above their rated capacity.

The writer has before him the operating statistics of two railway power stations, a comparison of which illustrates the importance of proper attention to this subject. For convenience they will be referred to as Station A and Station B. Both stations

furnish power for suburban railways upon which sufficient cars are run to provide a fairly uniform load during the greater part of the day, although subject to more or less violent temporary fluctuations. The general designs of these stations and their equipments are such that the fuel used per kilowatt-hour should be practically the same, provided the engines could be kept well loaded in both cases. In Station A there are three units, and the load conditions are such that one unit is operated during the night and early morning, when the travel is light; two are operated during the greater part of the day, and three at the peak of the load, which occurs shortly after 6 o'clock in the evening. By careful atention to the changes in the load it is always possible to keep the running engines fairly well loaded.

In the case of Station B there are two units. The load at night and early morning is very light, so that the engine used is only about half loaded for this period, whereas for the greater part of the day the load is a little more than one engine should be required to carry, and it is therefore necessary to run both engines. The result, of course, is that the average load on the station is only a little more than 50 per cent. of the rated capacity of the running engines, and they are, consequently, extremely wasteful of steam; and, too, the exhaust from the auxiliaries is probably quite a little in excess of that required to heat the feed water, which will also account, in a measure, for the low efficiency of the plant. Five pounds of coal per kilowatt-hour is the record of this plant, as compared with 3.8 lbs. for Station A. The greater part of this discrepancy is undoubtedly due to the more efficient load conditions in the latter station. It is probable that had a storage battery been added to the equipment of Station B, the load on the engines could have been regulated so as to have made a much better showing in coal consumption, but it is still problematical if there is any net gain from the use of storage batteries in railway work, and the writer is disposed to think that the use of three smaller engines in place of two large ones would have been the proper solution of the question. Undoubtedly a saving in coal of from 15 per cent to 20 per cent would have resulted from the use of engines better proportioned to the load.

In deciding upon the number and size of units, therefore, it is necessary that a careful study should be made of the load conditions throughout the entire day. In providing an increase of power for existing roads, data will be available from which station load curves under varying conditions of traffic can be constructed, and a fair average decided upon as the basis for determining the size of the units. In the case of a new railroad proposition, this information will be more difficult to obtain, and an approximate load curve will have to be constructed from a study of all of the conditions bearing upon the subject. This involves decisions upon such matters as the location of track, with special reference to grades and curves, the distribution of copper in the feeder system, the weight and equipment of cars and train schedules, all of which are important factors in determining upon the power required.

It is often necessary to estimate the size of a new power station before the final survey of the road is completed, or the details of the feeder system or train schedules definitely decided upon. In such cases the engineer will have to apply such data as he is able to obtain from other roads in which the conditions of track and the operating conditions are similar. But such data should always be used with the utmost caution, as vital differences in grades, in the feeder system, or in train schedules, must necessarily exist, which will render it extremely difficult to make comparisons sufficiently accurate for a final decision upon the size of the station.

Having ascertained the power required during the different hours of the day, the plant should be divided into as few units as will enable the engines and generators to be operated at or near their rated capacity, while at the same time a sufficient number should be installed so that in the event of trouble one can be shut down without causing interruption of service. A 3-unit station will permit of a fairly uniform distribution of the load in small plants, and in case of accident to one unit, the other two should be able by overloading, to supply sufficient power until repairs are completed. This number of units is therefore regarded as the minimum which should be installed in any power station.

The type of apparatus to be used, whether alternating or direct-current, will not materially affect the design of the station except in so far as the question of the use of reciprocating engines or steam turbines is involved. Up to this time the steam turbine, which is rapidly growing in favor for electric railway work, has been designed almost exclusively for use in connection with alternating-current generators, and the manufacturers of electrical apparatus have held out scant encouragement that its speed could ever be so modified as to make its use with direct-current generators, particularly the larger sizes, practicable. Reciprocating engines have, therefore, been regarded as the only type of steam motor available for this class of work. It is probable that this will be the case for some time to come, but it is interesting to note that considerable progress is being made in the development of direct-current turbo-generators. A number of machines of this type as large as 500 kw. capacity are in operation, and work is well advanced upon units as large as 2,000 kw. There seems to be a good ground for the belief that this problem will be successfully solved, and that in the near future this type of apparatus will be available in sizes as large as are generally required for direct-current work.

Engineers and steam users generally have been prepared for some time to welcome any form of prime-mover which could be shown to possess any considerable advantage over the reciprocating engine, as the latter had come to be regarded as having largely fulfilled its possibilities, and no very great improvement in economy was to be looked for. The steam turbine seemed to offer the solution of the question, and while, at the time of its introduction into this country, its superior economy had not been demonstrated, its great simplicity as compared with reciprocating engines, lower first cost, and less floor space occupied, insured its prompt adoption by a large number of power users, and from the first its progress has been rapid. In a report of the committee for the investigation of the steam turbine made to the National Electric Light Association last June, it was stated that there were in operation at that time 224 turbines of an aggregate capacity of over 250,000 horse-power, the greater number of which had been installed in the last two years. The writer is informed that the orders for turbines taken by the largest two manufacturers in this country aggregate (July 1, 1905), over 800,000 horse-power.

The remarkable progress made in the manufacture of these machines, and their general adoption by many of the most progressive railways in the country, proves them to be a most formidable competitor of the reciprocating engine, if, indeed, it does not indicate that they have already established their commercial superiority.

It is to be regretted that most of the data upon the efficiency of steam turbines have been derived from tests covering very short periods of time, usually only a few hours, and that so little data is available of their performance under actual service conditions. To the street railway manager or engineer, power station records for long periods, showing the coal consumed per kilowatt-hour, or, better still, the efficiency of the plant expressed in percentage of heat energy in the coal converted into electrical energy at the switchboard, are of much greater interest and value than the record of any number of short-time tests for steam consumption only, as it provides him with a much more practical means of making comparisons with the performance of other stations with which he is familiar. The data which have been published illustrating the relative economy in steam consumption of turbines and reciprocating engines rarely ever shows comparisons between units operating under identical conditions as to steam pressure, superheat, or vacuum and therefore does not fairly represent the relative performance of the two types, and, too, the steam consumption of the auxiliaries is also invariably omitted, so that it is impossible to form an intelligent opinion as to the additional cost of the higher vacuum required for the turbine.

Up to this time most of the turbines installed in electric railway power stations are operated in connection with reciprocating engines, and owing to the difficulty of separating the operating charges, it has been practically impossible to obtain reliable information as to their performance under commercial conditions.

One of the plants where turbines are exclusively used is the Quincy power station of the Old Colony Street Railway Company, and through the courtesy of P. F. Sullivan, president of this company, the writer is permitted to publish some in-

formation regarding the performance of this station. This information was kindly furnished by C. F. Bancroft, superintendent of motive power and machinery.

It should be stated at the outset that this station, which will eventually furnish power for that portion of the Old Colony Street Railway Company's system, extending from Quincy on the north to the city of Fall River on the south, is not yet in full operation. Its connection with the latter city, where a large part of the current is to be used, has not yet been made, so that at present it furnishes power for only about one-third of the number of cars which it will eventually drive. Only two of the five turbines in the station are required for this work. One of these machines is run for 17 hours per day, and two for 24 hours per day. When the station is in full operation there should be a more uniform load, and it is expected that the station efficiency will be considerably increased.

The station contains five 2,000-kw., 4-stage vertical turbines, running at 750 r.p.m., and connected to 13,200-volt, 25-cycle alternating-current generators. The steam pressure is 200 lbs. There are ten horizontal water-tube boilers of 750 horse-power each, equipped with internal superheaters, giving to the steam an average of 65° superheat. Under-feed stokers are used. There are no economizers. One turbine is supplied with steam driven auxiliaries; the other four have motor driven auxiliaries. At present, while only two units are in operation, the feed water is heated to 200° F. by the exhaust from the steam auxiliaries. The average daily output is 52,500 kw.-hours, giving a load factor of 54.7 per cent for the two machines. Georges Creek Cumberland coal is used, having an average calorific value of 14,000 B.T.U. per pound. The average coal consumption for this station, operating under the conditions outlined above, is 2.94 lbs. per kilowatt-hour, showing an efficiency of 8.36 per cent. This record covers a period of six months, ending June 30, 1905.

While this performance does not furnish conclusive evidence of the superiority of the turbine over reciprocating engines in electric railway work, it compares favorably with the results obtained in a large number of the better class of stations using the latter type of prime movers, and gives some force to the opinion that in actual practice there will be found to be very little difference in the coal consumption of steam turbine and reciprocating engine plants operating under similar conditions.

In order to develop the highest efficiency of the steam turbine, it is necessary to operate with a very high vacuum. It is claimed that each inch of vacuum above 26 ins. will increase the economy from 3 per cent to 4 per cent, and condensing apparatus is usually recommended which will produce a vacuum of about 28 ins. of mercury, or 2 ins. to 2½ ins. higher than that regarded as the most efficient for reciprocating engines. The type of apparatus generally installed consists of a surface condenser with a centrifugal circulating pump, dry vacuum pump and hot-well pump. In practice no trouble has been experienced in obtaining the high vacuum desired with this type of apparatus, but whether the gain of 3 per cent or 4 per cent in coal is sufficient to warrant the additional first cost and cost of operating this rather complicated system, is a question which would seem to be open to discussion. In cases where the cost of feed water is a material factor in the cost of power, or where it contains a large percentage of calcium or magnesium carbonate, or other scale-forming materials, there will be great advantage in using a surface condenser on account of the pure distilled water returned to the boilers, but where these conditions do not exist, it will frequently be found to be practicable to use some simpler form of condensing apparatus, such for example as the injector or barometric type of jet condensers. These types of condensers offer very great advantages over the surface condenser in the matter of lower first cost, space occupied, greater simplicity and less cost of maintenance. Up to this time they have not been very generally used, but there seems to be no good reason why they should not work as satisfactorily in connection with steam turbines as with reciprocating engines, and when properly proportioned to the work and installed with tight piping throughout, it is believed that in many cases they will prove to be as satisfactory as the more complicated types.

A considerable economy in the steam consumption of both reciprocating engines and steam turbines has been shown to result from the use of superheated steam. In plants equipped with either of these types of prime movers using dry saturated steam, the introduction of superheated steam can generally be depended upon to effect a saving in steam of about 1 per cent. for every 8 degrees or 10 degrees of superheat. Where the quality of the steam is not so good, and the conditions are such that the condensation in the pipes or cylinders of the engines is excessive, the saving may be much greater than this, sometimes amounting to 1 per cent for every 4 degrees or 5 degrees of superheat.

With reciprocating engines, condensation in the cylinder resulting from the great difference in temperature between the incoming steam and the surfaces of the cylinder which have just been exposed to the temperature of the exhaust steam, has been recognized as one of the greatest sources of loss. Various means have been employed to reduce this loss, such, for example, as the use of steam jackets and reheaters, but these devices add materially to the complication of the engine, and under the most favorable conditions only effect a partial saving. For these reasons they have not been generally adopted in power station work. Superheated steam has been found to be a much simpler and more effective method of accomplishing this result.

Our knowledge of the subject of steam turbines is still so limited that it is impossible to state with any degree of positiveness just where the various losses occur, or to what causes we must attribute the gain in efficiency from the use of superheated steam. Undoubtedly a portion is due to thermodynamic reasons, and it has been suggested that a large portion is also due to the diminution of fluid friction within the turbine. Owing to the very high steam velocities in this type of apparatus, the friction of the steam passing over the surfaces of the buckets must cause a considerable loss, and this probably very much greater where the steam carries a large percentage of moisture than when it is dry or superheated. It is probable, therefore, that the larger part of the gain due to superheating can be attributed to this cause.

The prevention of the deposit of water on the inside of the turbine casing, also, must effect some saving, although this gain is probably small as compared with that resulting from the diminution in the friction of the steam as it passes over the surfaces of the buckets.

Whatever the causes may be, there can be no doubt that there is a very marked gain in efficiency in steam turbines from using superheated steam, amounting to about as much per degree of superheat as in the better class of reciprocating engines.

The following table, compiled by R. M. Neilson, shows the reduction in steam consumption in steam turbines and reciprocating engines due to superheating. These statistics were obtained from a number of tests made in this country and in Europe. The apparent discrepancy in these tests is explained by the statement that there was considerable difference in the quality of the steam in the different cases, and the engines were of different types and of different sizes:

Steam Turbines			Reciprocating Engines		
Degrees Fahr. of Superheat	Percentage Reduction of Steam Consumption	Percentage Reduction per Degree Fahr.	Degrees Fahr. of Superheat	Percentage Reduction of Steam Consumption	Percentage Reduction per Degree Fahr.
13	6.1	0.47	31	7.86	0.25
50	8.0	0.16	40	8.65	0.22
60	5.4	0.09	50	12.00	0.24
66	12.1	0.18	100	20.55	0.20
70	7.5	0.11	100	13.00	0.09
84	7.7	0.09	216	36.4	0.17
100	14.0	0.14	225	33.7	0.15
140	12.6	0.09	225	33.1	0.15
150	19.0	0.13	440	30.9	0.07
200	23.0	0.115			
260	24.5	0.09			

Unfortunately, superheated steam is now known to be rather expensive to produce, particularly at the higher temperatures, and consequently economy in steam consumption does not necessarily mean economy in the consumption of coal. The chief advantage in its use is obviously in the saving which can be made at the coal pile, and unless this saving can be shown to be sufficient to pay for installing and operating the necessary superheating devices, it will be extremely difficult to convince a careful street railway manager that it will be profitable to use it.

This is a subject upon which there is a vast amount of conflicting information. In a number of instances the use of super-

heaters has been discontinued either on account of mechanical difficulties or because there was not a sufficient saving in coal to pay for keeping them in service. In other cases no mechanical difficulties have been experienced, and the saving in coal has been all that could be reasonably expected.

It is noteworthy that manufacturers of reciprocating engines and steam turbines, as well as engineers, while still recognizing the value of superheated steam, are disposed to be much more conservative than formerly in recommending its use. At this time, the weight of opinion seems to be in favor of a moderate amount of superheat, say not exceeding 125 degs. Within this limit there should be a sufficient saving at at the coal pile to justify its use, while the temperature is not sufficiently high to cause serious mechanical difficulties with any of the various types of steam apparatus generally used.

For many years after the inauguration of the electric railway industry, power station engineers seemed disposed to devote the greater part of their energies to perfecting the arrangement of engines, generators and switching apparatus, frequently neglecting the more important, though less showy, boilers and their accessories. In recent years they have come to realize that a larger percentage of saving can be made by a proper attention to the design and management of the boiler room than in any other department, as it is here that the greater number of preventable losses in a power station occur.

The designs of the standard types of steam boilers which are now generally used have been perfected to such a degree that efficiencies as high as 70 to 75 and even 80 per cent. have been attained under favorable conditions, and there are very few improvements which the power station engineer can suggest which will produce any considerable saving in fuel.

The design of the furnace, as distinguished from the boiler, on the contrary, is one requiring careful thought and study, to make it conform to the conditions required for the perfect combustion of the specific kind of fuel which is to be used. Anthracite coal, owing to its small percentage of volatile matter, can be satisfactorily burned in almost any kind of furnace, provided the grate area and the draft are sufficient to burn the quantity required to develop the desired capacity, but in the case of semi-bituminous and bituminous coals and lignites, containing a much larger percentage of volatile matter, the furnace should be so designed that this volatile matter, as well as the fixed carbon, will be completely burned in order to develop the full heating value of the fuel.

The following conditions are necessary to insure the complete combustion of the fuel:

1. A sufficient supply of air.
2. Thorough mixture of air and fuel.
3. A sufficiently high temperature of the air and the combustible gases to insure their ignition and perfect combustion before they come in contact with the cooling surfaces of the boiler.

The principal source of loss is due to imperfect combustion of the volatile gases, which are distilled very rapidly after fresh coal placed upon the fire, and not being mixed with air at a temperature sufficient to cause ignition, pass off unconsumed; or the air supply and the temperature being sufficient, they are allowed to come in contact with the comparatively cool surfaces of the boiler, and their temperature reduced below the ignition point before combustion is completed, so that they escape when only partially burned. The mixture, temperature and time are, therefore, important factors in the combustion of the volatile gases, and it follows that the combustion chamber should be of sufficient size to allow the gases to become thoroughly mixed, and that they should be raised to a sufficiently high temperature, and be protected by fire-brick walls and arches from the cooler surfaces of the boiler shell or tubes until the combustible portion has been entirely consumed.

As to the proper place to admit the air for the combustion of the volatile gases, D. K. Clarke says:

"It is a matter of perfect indifference as to effect in what part of the furnace or flue it is introduced, provided this all-important condition be attended to, namely, that the mechanical mixture of the air and gas be continuously perfected before the temperature of the carbon of the gas, then in a state of flame, be reduced below that of ignition."

A number of furnaces have been devised in which the air has been admitted at the bridge wall or at the sides or front of the furnace above the grate, and there have been many ingenious plans for heating this air to the proper temperature before its admission to the combustion chamber. Some of these furnaces have been fairly successful as a means of reducing the smoke, but it is doubtful if the admission of air above the grate has ever materially increased the efficiency of the furnace. By far the most common practice is to admit all the air through the grate, that required for the combustion of the volatile gases being heated to the proper temperature by passing it through the bed of incandescent fuel.

In many of the larger railway power stations the flue gases are regularly analyzed to ascertain the amount and distribution of the losses due to incomplete combustion and the amount of excess air admitted to the furnace, which information is necessary to enable those in charge to operate the boilers in the most efficient manner. The only way in which the waste which takes place in the furnace can be detected is by such an analysis, and its importance as a means of reducing boiler room losses is so great that it merits a much more general use.

In the combustion of coal the object in view is to produce the highest possible percentage of carbon dioxide per unit of fuel burned. The higher the percentage of carbon dioxide, the more perfect will be the combustion of the fuel and the higher the furnace temperature, as is shown from the fact that a pound of carbon burned to carbon dioxide will produce 14,000 B.T.U., while only 4450 B.T.U. will be produced when, on account of an insufficient supply of air, carbon monoxide is formed. The gas analysis will show the percentage of carbon dioxide, carbon monoxide and oxygen. This information will enable the chemist to determine the total heat in the escaping gases, the amount of unconsumed gas, and the losses due to an excess air supply, and will also indicate the cause of these losses and suggest the proper remedy.

A low temperature of escaping gases is frequently regarded as an indication of efficient furnace conditions, but it is quite as likely to be caused by an excess of cold air, due to too strong a draft, uneven fires, or leakages through the boiler settings. The true condition of affairs can only be revealed by means of an analysis of the flue gases. Anything which will increase our knowledge of the conditions which take place within the boiler setting, and will permit a more intelligent use of fuel, should be encouraged, and for that reason the practice of analyzing the flue gases is recommended in all railway power stations where the cost of fuel is an important factor in the cost of power. It is always preferable to have this analysis made by an experienced chemist, but in small stations where the saving to be made is not sufficient to warrant the employment of such a man, it is said to be possible to obtain fairly satisfactory results from the use of one of a number of automatic or semi-automatic devices which are now manufactured for the purpose.

Mechanical stokers are now almost universally employed in electric railway power stations, on account of the increased efficiency over hand-fired furnaces and the reduced cost of operation. In a properly constructed furnace of moderate size, equipped with flat grates, an intelligent and careful fireman will produce results equally as satisfactory as any which have been obtained with any of the various types of mechanical stokers; but the trouble is that such firemen are not plentiful, and it is extremely difficult to secure men who will produce uniformly good results for long periods of time. For this reason the average fuel economy in a railway power station will generally be found to be somewhat better where the firemen are assisted by some form of mechanical stoking device.

It should be borne in mind, also, that in order to economize in space and the initial cost of the plant, the size of the boilers and the rate of combustion has steadily increased in the last few years until they have now reached a point where it is doubtful if the larger sizes can be properly stoked by hand, even by the most competent firemen.

The use of mechanical stokers is necessary in connection with these large sizes of boilers, in order to drive them up to the capacity required in electric railway plants.

There can be no doubt that mechanical stokers accomplish a considerable saving in boiler house labor. A reasonable day's work for a fireman is the shoveling of suffi-

cient coal for about 500 horse-power of boilers, which in a railway power station will amount to from six to eight tons every twelve hours. Where automatic stokers are used, and coal is delivered to the hoppers by gravity, one man should be able to take care of about 2,000 horse-power of boilers, which is equivalent to a reduction in labor of 75 per cent. The cost of maintenance of automatic stokers is somewhat greater than that of flat grates, and additional labor is required for repairs as well as for tending the coal handling machinery usually installed in connection with them, so that the net saving in labor will be somewhat less than that indicated above. There is a point, of course, at which this saving is not sufficient to pay for the additional fixed charges and repairs upon the mechanical stoking devices. This point is reached in a boiler plant of about 2,000 horse-power capacity. In a plant of greater capacity than this, automatic stokers can generally be shown to return a sufficient net saving to warrant their use, while in smaller plants it will frequently be found to be profitable to use them on account of the cheaper grades of fuel which can be burned and the greater capacity which can be gotten out of the boilers.

Perhaps the most difficult problem to be solved in connection with the power station is to secure proper attention to details of operation by the subordinate employees. In the most carefully designed plant, equipped with the most efficient types of machinery, the results which the railway manager and designing engineer may reasonably expect in the way of economy will not be achieved unless the utmost care and vigilance are exercised by the operating forces. The successful operation of the station will depend largely upon the way in which the forces are organized, and discipline maintained. Just how the station organization should be made up is a question which can only be decided for each plant after a careful study of all the conditions; but it is safe to say that however the various departments may be organized, there should be one man in supreme authority, possessing considerable executive ability as well as a thorough practical knowledge of steam and electricity, whose decision should prevail in the event of disagreement among the heads of departments or at times of emergency. As he is the one who will be held responsible for the successful performance of the station, it is essential that whatever regulations there may be regarding the employment of his subordinates, he should have full authority to dismiss any who prove to be incapable or are not disposed to be attentive to their duties. It will be practically impossible to maintain proper discipline if among the employees there are those who feel a certain sense of security in their position through the influence of some one higher in authority than the man in charge of the station.

The work of the greater number of station employees is necessarily of a routine character. It is nevertheless important that they should be thoroughly instructed in their duties and required to perform them with the utmost regularity. For example, an oiler employed upon an engine should receive instructions as to the minutest detail of the work that he is required to do. He should not only be required to see that his lubricators are full and working properly, and that every part is receiving a sufficient quantity of oil or grease, but he should feel of every bearing, and should observe every part of the engine as he passes around it to assure himself that it is in proper operative condition. He should be required to perform these duties at regular intervals of every 20 or 30 minutes, and his attention should be called to the time for him to commence his rounds by a bell or whistle, or some other form of signal. If there is any part requiring attention, it should be immediately reported to the engineer in charge, who will thus be given an opportunity to apply the proper remedy before the trouble has developed to such an extent as to cause damage or interruption to the service. If the oiler attends to his duties properly, there will be no trouble from hot bearings, from keys, pins or bolts working loose, or from any change in the adjustment of any part which it is possible to discover when the engine is running.

The work of all other station employees should be systematized along the same lines. The watch engineers should report in writing to the engineer in charge details of the apparatus which in their judgment require attention, and as soon as the machinery can be shut down these parts should be carefully inspected, and if they show signs of weakness or excessive wear, immediately renewed or repaired. An examination of the enclosed parts of the engines and other working machinery should also be made at frequent intervals and before there are any outside evidences of trouble.

It is necessary that all subordinate employees should be under constant supervision to insure a proper attention to their duties, but this is especially true of the fire room forces. Firemen are not generally disposed to take as much interest in their work as employees in other departments. They seem to be content to remain as firemen, and rarely endeavor, by excelling in their work, to advance their positions. It is in this department that the greatest losses will occur through indifference on the part of the attendants, and it is therefore of the utmost importance that their work should be carefully done. The only way to accomplish this known to the writer is to place this department in the immediate charge of an intelligent and capable man, whose salary and the knowledge that the permanency of his position will depend upon the results produced, will be sufficient for him to keep constantly in touch with those immediately under him and insist upon their performing their duties properly.

In most power stations records are kept of the coal and water consumption, the temperatures of the feed-water and flue gases, and the station output, by which the performances of the station from month to month can be compared. These records furnish a check upon the condition of the station, the manner in which it is operated, and assure its being maintained in a high state of efficiency. The writer has found that in addition to these records an occasional test of the entire plant under actual operating conditions for periods of, say, 24 to 48 hours, are also of great value as a means of furnishing definite knowledge as to just what the station is capable of doing. Such tests also have a certain educational influence upon the employees, particularly the firemen, as they illustrate to them what can be done when all engaged on the work are exerting their best efforts to secure the most efficient results possible.

At the Rhode Island Suburban Railway Company's Manchester Street station all of the usual records are kept, and the quantities and costs carefully determined for each month, and tests of the entire plant are also made as suggested above. The writer believes that these tests have a sufficient influence upon the regular performance of the station to justify a brief description of it, and the publication of the results in the matter of coal consumption from the time it was placed in commission, showing the gradual improvement in efficiency.

This station was originally designed for the Rhode Island Suburban Railway Company to furnish power for its lines operating in the vicinity of Providence. It was intended to use horizontal units, and two 1,500-kw. alternating-current units and one 1,600-kw. direct-current unit were purchased. Before work on the building had progressed beyond the foundations, however, it was decided to increase the capacity of the station by installing two additional direct-current units of 2,500-kw. each. This required a number of changes in the structure, and necessitated double-decking the boiler room in order to provide the necessary additional boiler capacity. The present equipment of the station consists of fourteen horizontal water-tube boilers of 520 horse power each, eight on the lower floor and six on the upper floor. The boilers on the lower floor have no superheaters, but those on the upper floor are equipped with internal superheaters, each made up of eighty-four 2-in. tubes, suspended below the boiler drums. The superheaters on two of the boilers were designed for only 125 degrees of superheat, and contain 615.3 square feet of effective heating surface each. Those on the other four boilers were designed for 150 degrees of superheat, and contain 855.5 square feet of heating surface. Each boiler has 5,159 square feet of heating surface.

Roney mechanical stokers are used, each containing 112 square feet of effective grate surface. A 280-tube Green fuel economizer is installed directly back of each battery of boilers, the flue being so arranged that the hot gases may be passed through the economizers or directly to the main flue as desired. The heating surface per square foot of grate is for boilers 46 square feet, for economizers 15 square feet, or a total of 61 square feet. Natural draft is used. The boiler pressure is 145 pounds. There are

three horizontal compound engines with cylinders 32 inches and 64 x 54 inches, operating at 94 r.p.m., and two vertical compound engines with cylinders 42 inches and 86 x 60 inches, operating at 75 r.p.m. All of the engine auxiliaries are steam driven. Jet condensers are used, the air pumps being of the twin vertical type. The average vacuum in the engine cylinders is 25½ inches of mercury. There are two alternating-current generators each of 1,500-kw. capacity, delivering current to the line at 11,000 volts, and one 1,600-kw. and two 2,500-kw. direct-current generators delivering current at 600 volts. The normal capacity of the station, therefore, is 96,000 kilowatts. Direct current is furnished for 24 hours per day, and alternating current from 5 a. m. to 1 a. m. There are no feed-water heaters between the engine cylinders and the condensers, but the exhaust steam from the auxiliaries is carried to two heaters located in the basement on the suction side of the feed-pumps. These heaters are made up of horizontal U-tubes arranged in series, the steam entering at the top and discharging at the bottom, while the water enters at the bottom and discharges at the top. Each heater contains 750 square feet of heating surface, and in practice all of the steam from the auxiliaries is condensed and is discharged at a temperature only about 35 degrees higher than the incoming cold water. The average daily output of the station is 102,500 kilowatt-hours.

The following is the performance of the station under actual service conditions from the time it was started in regular service, February, 1904. It should be borne in mind that the first battery of boilers with superheaters was installed eleven months after the station was started, and four months thereafter two additional batteries of boilers with superheaters were commissioned, and the performance of the station is therefore given for the period covered by these different conditions.

Eleven months, saturated steam, 2.87 pounds of coal per kilowatt-hour.

Four months, slightly superheated steam (no record of temperature kept), 2.73 pounds per kilowatt-hour.

Three months, superheated steam, average temperature at engine throttle 465 degrees (102 degrees superheat), 2.46 pounds of coal per kilowatt-hour.

The apparent reduction in coal consumption per kilowatt-hour with steam superheated about 100 degrees is 14.3 per cent., but all of this saving cannot be attributed to this cause. A large part of it is undoubtedly due to the increased efficiency of the fire room attendants. Probably not over 8 to 10 per cent. should be credited to the use of superheated steam.

[The foregoing is a paper read at the Philadelphia convention of the American Railway Mechanical and Electrical Association.—EDITOR.]

Steel versus Cast Iron Fly-wheels.—Steel fly-wheels having a tensile strength of 60,000 pounds per square inch will stand a speed 90 per cent greater than fly-wheels made of cast iron.

ESTIMATING ON CONTRACT WORK.

BY LOUIS J. AUERBACHER.

The problem of estimating is simply one of analysis. When figuring on the cost of wiring a building according to a set of plants and specifications, the contractor should first carefully read the specifications to ascertain if they contain any unusual requirements. In reading the specifications the contractor should note if he is expected to do cutting and plastering, and also note if any scaffolding is required. These items increase the expense, and if not counted lessen the profit.

The specifications for the wiring of a building are usually divided into the following clauses:

- General Conditions.
- System of Wiring.
- Mains and Feeders.
- Panelboards.
- Circuit Wiring.
- Special Devices.

If the plans and specifications give the complete data, such as the size of feeders and the locations of panels, the contractor has only to write down the details on an analysis sheet (Form A) and add the cost of labor. Where the complete data are not given it is necessary for the contractor to lay out the wiring systems and take the data from these.

In making up an analysis sheet when estimating for wiring a building for electric lights, using a conduit system, all items coming under the head of panels, such as meter boards, service boards, panels, switches, distributing boxes, etc., are written down first. If the contractor has sufficient time a list of these should be made up and sent to two or three manufacturers for quotations. If the panels called for are standard, the last price of similar goods should be used.

The length of run of the mains in feeders is then measured and recorded, together with the quantity of wire and conduit required; the labor is also estimated. The circuits are next measured and the length of pipe and wire required written down; also fittings, such as elbows, couplings, lock nuts and bushings. By adding 10 per cent to the cost of the pipe, the fitting item is usually provided for. The number of outlet boxes, switch boxes, switches, receptacles, etc., and the labor for installing them are then added, together with a sum for sundries, such as cartage, car fares, inspection fees, etc.

An estimate should always be on the safe side. If better cost prices are obtained later these often offset unforeseen contingencies. In figuring the labor cost the contractor must be guided by past experience and data from the cost book. The cost for installing conduit is usually quoted at so much per thousand feet; molding, at so much per hundred feet; cleats, at so much per hundred pair, and so on.

When making a quotation, the contractor must take into consideration the amount of competition. If possible he should find out who his competitors are and how they have bid on similar work. A good plan is to add to the cost of the material a certain percentage of profit. This percentage may

ANALYSIS SHEET

LOCATION OF BUILDING ______ DATE ______ 190
ARCHITECT ______
ENGINEER ______
OWNER ______
ESTIMATES TO BE SENT TO ______

		MATERIAL	LABOR
	TOTAL COST $		

Amer. Elec.

FORM A (*White*). Actual size, 8 inches wide by 12 inches long.

CIRCUIT ANALYSIS

LOCATION OF BUILDING ______ DATE ______ 190
ARCHITECT ______
ENGINEER ______
OWNER ______
ESTIMATE TRANSFERRED TO GENERAL ANALYSIS SHEET NO. ______

FLOOR	CIRCUIT	OUTLETS		SWITCHES	RECEPTACLES	FLOOR RECEPTACLES	FEET OF PIPE	FEET OF WIRE	FITTINGS		
		SIDE	CEILING						ELBOWS	COUPLINGS	LOCK NUTS AND BUSHINGS
TOTAL											

Amer. Elec.

FORM B (*White*). Actual size, 8 inches wide by 12 inches long.

be smaller than the percentage added to the labor cost, inasmuch as the material can be accurately estimated, whereas labor is always an uncertain item, and the percentage added should be larger to compensate for the risk.

In making estimates care must be taken to learn the character of the construction of the building. When estimating on work for a finished house it makes quite a difference whether the building is furred or not. If furred, the wires are easily "fished"; if not, floors must be taken up and the beams bored. The cost of labor is naturally double in buildings not furred.

In figuring on a molding job, the fact that the ceiling is of lath and plaster and therefore requires the molding to be fastened with screws, makes the cost of labor greater than if the ceiling were such that nails could be used. In close competition, these minor points favor profits.

In estimating without plans, as is the case when one is asked to look over a building, the best plan is to figure per outlet. For example, on an open-work iron pipe job, experience and reference to the cost book will indicate that the cost per outlet is, say, $3.50. To this must be added the cost of feeders and panels. These latter may be put down at $20 erected and feeders, if of average size, at 35 cents per foot. In figuring on drop lights, a certain percentage should be added to the cost per drop. On molding or cleat work the procedure is the same. Where the job is large and warrants the drawing of a plan, this should be done and an analysis made in order to check the prices per unit.

Another way of estimating is to figure the number of lights, and if fairly distributed, average them ten to a circuit. If the building is of average size, it is safe to assume each circuit to be 75 feet long. This will give approximately the number of circuit feet. The rest of the details, such as feeders, panels, etc., can be easily approximated.

When estimating on very large jobs, a circuit-detail analysis sheet, such as is shown in Form B, is often used. The total on this sheet is carried over to the general analysis sheet. These analysis sheets should be carefully filed in a special cabinet. All amendments or changes in the plan should be filed with the original. If a contract is obtained the analysis sheet should be used by the foreman as a basis on which to order material. The sheet should also be compared with the cost books when the work is completed. By this means much valuable information is often obtained. If the job was unprofitable through faults in estimating or through uneconomical management, reference to similar jobs and an analysis of details should indicate where the blame lies.

Estimating on large buildings should be no more difficult than estimating on small buildings; if large jobs are treated as a group of small jobs, the problem becomes quite simple. The cost of labor is naturally perplexing; yet there is no reason why on a straight job in a new building the time should not be practically the same in all cases. A man and a helper should put up so many feet of pipe or molding, as the case may be, in a day, and it is the foreman's duty to get at least that much work out of them. By revising the cost system as new conditions arise, the cost per unit of labor may be made a fairly certain item.

In measuring the number of circuit feet on a plan, a rotometer will save time and promote accuracy. An instrument of this kind made by Kolesch & Co., of New York City, is shown in Fig. 1. The little wheel is caused to run along the circuit lines

FIG. 1.—THE ROTOMETER.

and the dial registers in feet and inches. If the drawings are made to a scale of ¼ inch to the foot, the reading is multiplied by 4 to obtain the circuit feet. As these measurements do not provide for the side wall runs to side outlets and switches it is necessary to add a certain number of feet to provide for these. A good plan is to total the number of side outlets, switches and receptacles, also the number of circuits for runs to panels, and multiply this total by 10 if the ceilings are of medium height. This will provide for runs down to outlet and back to ceiling for a run to another outlet or switch. By the use of the rotometer the number of circuit feet of a large plan can be ascertained in a very short time.

ENGINE ROOM ECONOMIES.

An interesting paper upon engine room economy was read at the recent Hospital Superintendents' Convention in Boston by Chief Engineer Jeremiah C. Long, of the Boston City Hospital. The subject was discussed entirely from the practical standpoint and in a comprehensive way the essentials of good practice were emphasized. In the main the author devoted his attention to the steam ends of the power and distributing plants. At the outset he pointed out the advisability of using high steam pressure in preference to low in transmitting steam to a large group of buildings, especially in cases where the maximum distance covered approximates 1000 feet. It is more economical to carry a pressure of 90 pounds underground in a proper size of pipe than to use 5 or 10 pounds directly in the steam main from the power house. The reducing valves of the heating system will operate as well at one end of the line as the other. The principal losses are due to radiation and friction. With the proper size of pipe the loss due to friction should be about 20 per cent of the radiation loss when the sum of the two is a minimum. Using 90 pounds pressure the loss is probably 30 per cent less than with a pipe twice as large and a maximum of 10 pounds.

A good method of protecting underground pipes not laid in brick ducts is to lay them, covered with asbestos and hair felt in a box made of 2-inch plank. The loss in pipes protected in this way should not exceed 20 per cent of the loss in the case of bare pipes. In connection with the heating system Mr. Long presented the following method of estimating the total square feet of area required in the heating coils: To one-tenth of the wall surface add the full glass surface; to this sum add the cubical contents of the building divided by 100. Then eight-tenths of the total will be the area of coils required for direct radiation, and for indirect radiation multiply by 1.5 instead of by 8.

A large part of the paper was devoted to the discussion of various leaks in plants. All these cost money, but the importance of stopping them is not always appreciated. Losses often occur through the carting away of unburned coal in the ashes, which may arise from poorly set or constructed grates in the boiler furnaces or from the careless permitting of clinkers on the furnace wall. When these are finally dislodged the brickwork sometimes comes down, leaving gaps through which unburned fuel falls into the ash pits. Leaks at pipe joints are frequently encountered and the use of higher pressures has increased the tendency to trouble. Pipe clamps should be used only temporarily, as their constant application tends to produce a patched-up system liable to go to pieces suddenly and cause great trouble. Piston rod stuffing boxes should not be allowed to leak on the supposition that a rod is running free when it is leaking. If an engine is out of line or the piston needs re-centering either will become worse daily if allowed to continue. Some plants allow blow-off cocks to leak just a little to keep them free. This is an expensive policy, and if the water contains scale the deposits are sure to make trouble in time by clogging. With feed water at 40° F. and steam at 100 pounds pressure a loss of 1 pound of coal occurs for each 33 pounds of water passing through the blow-off cock. This applies as well to sterilizers and leaky safety valves.

If the suction valves on a steam pump leak the water is forced back into the tank, and if the discharge valves and check valves on the feed pipe leak water will be forced back into the pump cylinder. This is all useless and expensive work.

A recent test at the Massachusetts Institute of Technology made upon a 6-inch uncovered steam pipe carrying 100 pounds pressure per square inch in a still room at 72° F. gave a loss of 14.5 B.T.U. per foot of length. On this basis a 6-inch bare pipe carrying 100 pounds and 100 feet in length would cause a loss of 87,000 heat units per hour. Allowing 75 per cent efficiency in the burning of the coal, about 8.7

pounds of coal per hour would be required to make good this loss on a calorific power of 14,000 B.T.U. per pound, and in a year at $3.50 per ton the waste would amount to $131.40. The best pipe coverings on the market will reduce this 75 per cent. Another source of loss comes from not using exhaust steam in heating feed water. Live steam should be cut off from steam tables, hot water boilers, stock kettles, dish warmers and sterilizers where such equipment is not in use. In the engineering department of a hospital it is easy for the laundry machinery to be a special source of trouble. Engine leaks, shaky shafts, slipping belts, toothless cogwheels, dry room doors carelessly left open and similar defections do not increase operating economy. Temporary repairs in such cases should not be allowed to become permanent, where new parts can readily be obtained.

The final section of the paper discussed at considerable length the disadvantages of boiler scale. The heat conducting power of scale is in general only about 74 per cent that of iron; 1/16 inch of scale means 15 per cent more fuel; ¼ inch of scale, 60 per cent, and ½ inch, 150 per cent. Under good conditions the temperature of steam at 90 pounds pressure is 320° F. With ½ inch of scale the boiler must be heated almost to a low redness, 700° F., in order to raise steam to 90 pounds. Above 600° iron becomes brittle and granular from carbonization or corrosion to a cast-iron state, and the danger of explosion is great. On a fair average a 125-h.p. boiler would in one year use 20 per cent more fuel than with pure water, if the scale were allowed to accumulate. At 5 pounds of coal per horse-power-hour, 2730 tons would be burned per year of full load running, costing at $3.50 per ton, $9555. The presence of scale would increase this cost by nearly $2000.

Abstracts from Foreign Contemporaries

Protection Against Potential Rises in Transmission Systems—It is well known that in the operation of extra high potential systems of distribution of electrical energy certain conditions tend to the production of dangerous rises in the potential of parts of the system. In order that these may be rendered harmless, it is essential that adequate means be provided to relieve the strain thus thrown on the insulation of the circuit, both as regards transmission lines and machinery. M. M. E. Dusangey, in a paper read before the Société Internationale des Electriciens, discusses the types of apparatus now in use by various Continental companies for this purpose on systems working up to 30,000 volts. As predisposing causes to pressure rises, he mentions (*a*) Atmospheric influences; (*b*) Resonance; (*c*) A sudden break in the circuit; (*d*) Accidental contact with other systems at a higher pressure. The author divides protective devices into two classes: (1) Intermittent; (2) Continuous. Those in the former class are designed to give a momentary discharge to earth by way of a suitable arrangement of spark gaps, having means provided for destroying the resultant arc, and a limiting resistance in the path of the discharge. The second class includes high resistances of liquid or metal wire always in circuit and arranged to pass any excess voltage to earth. These give a continual energy loss, and are known as "over-voltage discharges." The location of such apparatus cannot always be determined originally, but as a general rule protective devices are placed at the entrance and exit of lines to and from sub-stations and power stations, and at the junctions of underground lines and overhead trunks. Other devices are added subsequently at such places as are found necessary. The author proceeds to describe several devices in use. In one case (Société d'Energie Electrique du Littoral Méditerranéan) lightning arresters are arranged with 16 air-gaps in series for 10,000 volts, each gap being 1.25 mm., and having eight carbon resistances of 250 ohms each, arranged in series to earth. For 30,000 volts, 48 gaps and resistance totalling 8000 ohms, are in use. As an "over-voltage discharger" the same company uses nine air-gaps of 1.5 mm. in series, with 10,000 ohms resistance in three sets arranged in Δ between the wires. Lightning arresters of the horn and magnetic blow-out types are also in use. When used as lightning arresters by the Société d'Energie Electrique de Grenoble et Voiron, a resistance of 8000 ohms (wet sand) to earth and one air-gap of 7 mm. are in combination for 15,000 volts. The same horn arresters, when connected as over-voltage dischargers, have 14,000 to 15,000 ohms in series. Another company (Société Hydroélectrique de Vizille) uses earthenware tubes filled with water as limiting resistances. These are 80 cms. long for 10,000 volts. Still another company (Cie Vaudoise des Forces Motrices des Lacs de Joux et de l'Orbe) arranges for a jet of water from a tank to fall into a metal cup connected to the earthed plate of a horn arrester. The water flows from these cups into a second tank kept at earth potential. A modification of this device (Société Hydro-électrique de Guiers) used as an over-voltage discharger, is an arrangement of three water jets from an earthed iron pipe, playing on terminal plates connected one to each line. The author concludes with the following suggested arrangement of protective devices: Outside the station, protected from the weather, lightning arresters, of either the horn or magnetic blowout type, are connected between each line and earth. Between this and the station, spark gaps are arranged in series between each wire and earth (by way of high resistance) to act as an over-voltage discharger; this is arranged to operate at 50 per cent. excess pressure. Inside the station a continuous discharge of 0.2 to 0.5 of an ampere takes place by way of a high resistance to earth. Between this and the switches kicking coils are inserted, and again between the switches and machines similar kicking coils. Still another discharger of horn arresters and non-inductive resistances is connected in Δ between the switches and machine kicking coils.

Electric Ignition Device for Gas Engines.—In electrical ignition devices for internal-combustion engines using charges of varying thermal value, it is of great importance that the time of firing should be capable of variation according to the rate of inflammation of the fuel used. An arrangement devised for this purpose is described in the *Mechanical Engineer*, and consists of an improved trip mechanism for use with a low-tension magneto with an oscillating armature. Fig. 1 is a view in side elevation of the mechanism. The armature of the magneto, which is of the usual low-tension type, is actuated by a bell-crank lever A through a rod A_1. The bell-crank lever is moved through the necessary arc to produce the oscillation of the armature by means of a reciprocating rod B pushing—during a portion of its stroke—against a trip lever C pivoted at C_1 and connected to the rod D at D_1, the reciprocating rod B being driven by a crank E on the half motion shaft X of the engine. When the point B_1 of the reciprocating tripping rod B moves below the point of the trip lever C the springs on the magneto or an auxiliary spring such as F operate to pull the bell-crank lever A back to its normal position, and at the same time cause the end of the rod D to strike against the contact lever G of the sparking device and thus cause contact to be broken in the

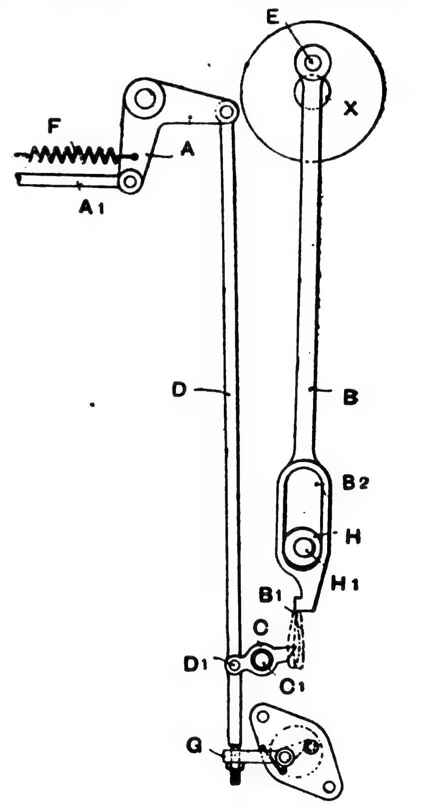


FIG. 1.—ELECTRIC IGNITION DEVICE FOR GAS ENGINES.

cylinder whereby a spark is produced. The reciprocating tripping rod B is supported near its tripping point by a pin working in a slot B_2. By moving the pin transversely with respect to the line of movement of the rod B the time of the release of the armature and consequently of the spark can be varied as desired. A convenient method of accomplishing this regulation is to make the pin in the form of an eccentric H capable of being rotated on the fixed pin H_1, thus raising or lowering the orbit of the travel of the trip point B_1 of the reciprocating tripping rod B.

Motor-Driving Arrangement for Lathes.—The accompanying illustrations show a recent design of lathe headstock directly driven by means of an electric motor. In this design the lathe spindle and the first and other motion shafts are easily accessible for the adjustment or removal of their bearings; the motor is so arranged as not to interfere with the accessibility of the various parts of the lathe mechanism, and so as to occupy a minimum of space, while at the same time the arrangement of the gearing is such that the usual lateral movement of the motor spindle while running is allowed for. Referring to the illustrations, for which we are indebted to the *Mechanical Engineer*, the face plate A is driven directly by a pinion B secured to the back of the face plate. A transverse shaft C passes beneath the lathe spindle D, to which is directly coupled by an ordinary flange coupling E, the electric motor F. This first transverse shaft C carries a pinion G gearing with a pinion H on a second shaft J. The shaft J also carries a bevel pinion, K, gearing with a bevel wheel, L, fast upon a shaft, M, and which may be termed the first motion shaft of the lathe. Since the transverse motor shaft, C, drives through spur gearing, it is obvious that it may be allowed end play sufficient to give the motor armature the endwise movement necessary. With this end in view the pinion G is made slightly narrower in face than the pinion H, the teeth of the former thus remaining laterally within the teeth of the latter notwithstanding the endwise movement. The end of the shaft C remote from the motor and the corresponding end of the shaft J are carried in a bracket N. This bracket is shown more clearly in Fig. 2, and its lower depending end is bolted to a standard O cast on the headstock base P, and it is so shaped as to form one-half of the journal of each shaft C J, the other half of each journal being formed by caps, Q R, while, as shown in Fig. 3, an aperture is formed in its lower depending part for the passage of a shaft S, forming part of the usual lathe gearing. The inner end of the shaft J is carried by a bearing secured to the top of a second pedestal T cast on the headstock base P, this bearing being also provided with a cap U. The "first speed" of drive for the lathe passes through a pinion V upon the first motion shaft M directly to the face plate pinion, B, and the pair of pinions G H, the bevel wheel L, and pinion K. The other speeds desired are obtained by the use of pinions of various proportions upon the first motion shaft and upon the shaft S, which is beneath and parallel therewith, connecting and disconnecting devices (not shown) being employed and the ultimate drive taking place in all cases through the faceplate pinion B and the pinion V on the first motion shaft M gearing therewith. The motor F, driving the first transverse shaft C, is directly coupled to that shaft by the coupling E and is arranged at the rear of the lathe. The arrangement possesses several advantages over those ordinarily used, in that it allows of the placing of the motor to the rear of the lathe where it is out of the way, and where, owing to its position, it may be arranged so closely to the lathe that little if any greater width is required. Further, since the transverse motor shaft C is below the spindle D, the bearing of the latter may be adjusted or it may be bodily removed without interfering with the driving gear; while the first motion shaft M, the second transverse shaft J, and the transverse motor shaft C may all be removed successively in the order named, or their bearings be adjusted in their original position.

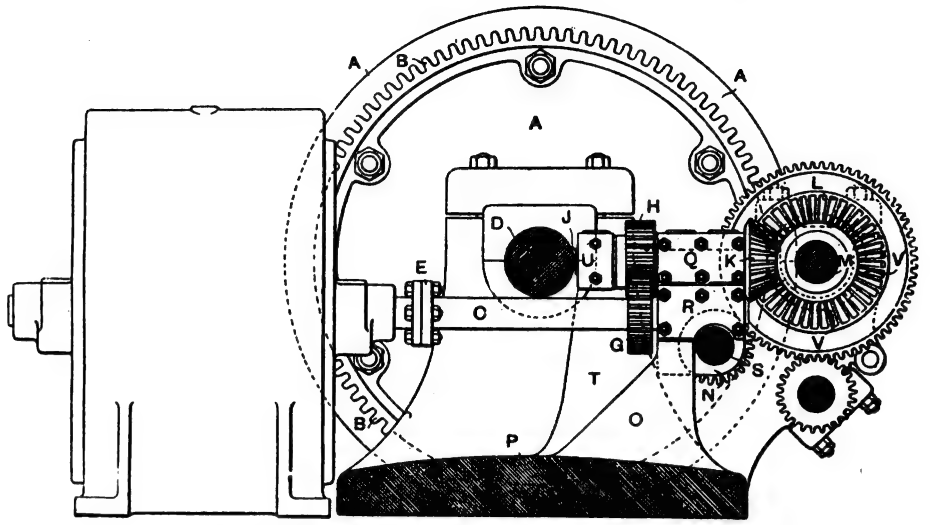


FIG. 3.—MOTOR-DRIVING ARRANGEMENT FOR LATHES.

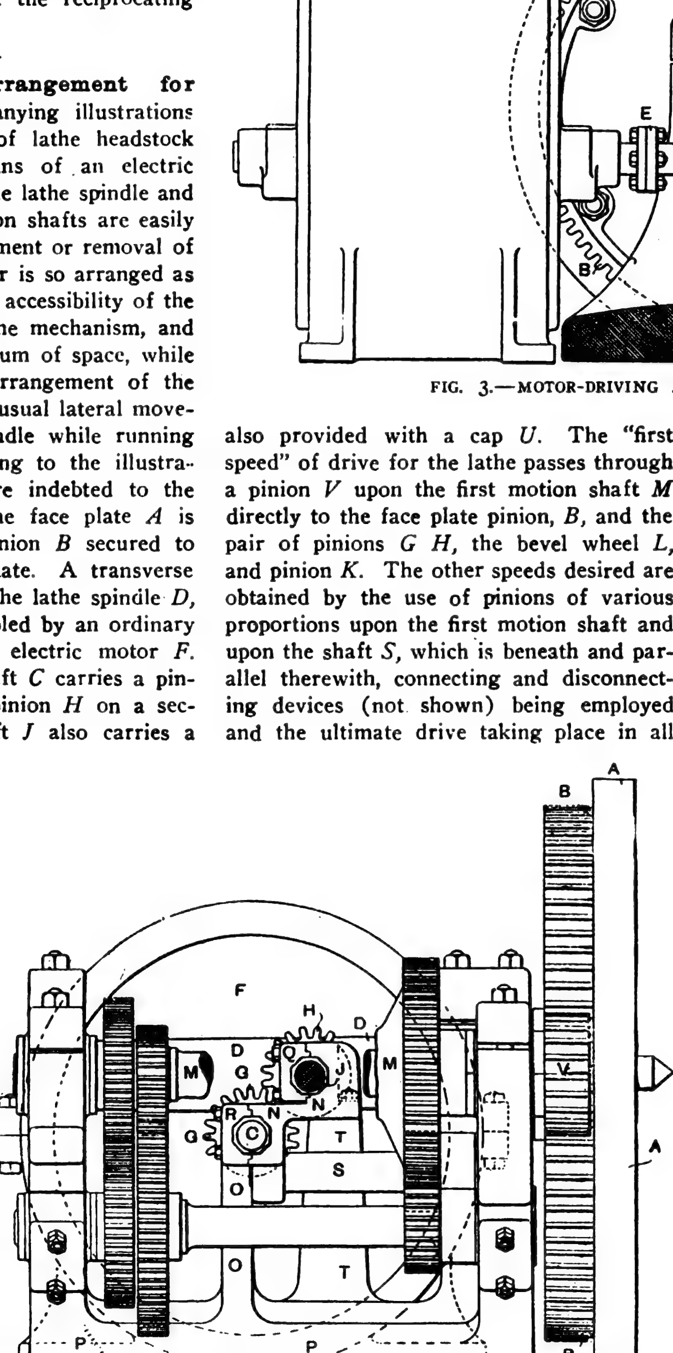


FIG. 2.—MOTOR-DRIVING ARRANGEMENT FOR LATHES.

Calculations of Mean Spherical Candle-Power.—J. Wild contributes to a recent number of the *Electrical Engineer* an account of a method by which the mean spherical candle-power of an ordinary incandescent lamp can be calculated with an error not greater than ½ per cent. from measurements taken at angles differing by 30 degrees. Measurements taken every 30 degrees would not suffice in the testing of an arc lamp or any source of light the candle-power of which undergoes great changes at small angular differences, but for ordinary incandescent lamps the mean spherical candle-power calculated every 30 degrees is sufficiently accurate for ordinary purposes. The method is simply to multiply the measured values of the mean circular candle-power at angles of 0, 30, 60 and 90 degrees above and below the horizontal with certain factors and to add the products to obtain the mean spherical candle-power. These multiplying factors with which the circular candle-power at different angles is to be multiplied are as follows:

	Multiplying Factor.
Angle 90 deg. above horizontal	0.017
" 60 deg. above horizontal	0.1295
" 30 deg. above horizontal	0.224
" 0 deg. horizontal	0.259
" 30 deg. below horizontal	0.224
" 60 deg. below horizontal	0.1295
" 90 deg. below horizontal	0.017

Economy of Arc Lamps.—The *Elektrotechnische Zeitschrift* publishes a long discussion of the economy of various types of arc lamps with special reference to the number connected in series. It is pointed

out that there are a great many different factors besides energy consumption which must be taken into account in determining the economy of a given type of lamp, and the article contains a number of tables and diagrams comparing the economy of the different lamps with respect to energy consumption alone. The following table gives the watts consumed in order to obtain 2,000 Hefner candles with ordinary carbons and with flame arc lamps:

Ordinary Carbons.		
110 volts,	2 lamps in series,	1250 watts.
110 volts,	3 lamps in series,	1060 watts.
220 volts,	4 lamps in series,	1575 watts.
220 volts,	5 lamps in series,	1350 watts.
220 volts,	6 lamps in series,	1350 watts.
Flame Arc Lamps.		
110 vols,	2 lamps in series,	800 watts.
220 volts,	4 lamps in series,	950 watts.
220 volts,	5 lamps in series,	1000 watts.

These results are of interest when lighting installations are planned for towns of medium size. Many customers, for instance, can use two or three arc lamps, but no more. At 220 volts it is necessary to use a larger number of lamps, whereby the cost of installation is increased. Moreover, with the same consumption of energy less light is obtained. Further, it will be noticed that the connection of six lamps in series is not superior to five lamps. It may be different, however, if in a larger installation a certain number of lamps is prescribed. If sixty lamps are required, it will be possible to get more light by connecting six lamps in series than five in series. For instance, 13.2 kilowatts give in such a case 20,000 Hefner candles for ten circuits each containing six lamps in series and each consuming 1.32 kilowatts. The same energy gives 16,800 Hefner candles in twelve circuits each containing five lamps in series and each consuming 1.1 kilowatts. With enclosed arc lamps the energy consumption is almost always higher, enclosed lamps being superior only for small intensities of light. The whole situation is, however, changed if the consumption of carbons, cost of attendance, interest and depreciation are considered. It is shown that for small intensities of light the enclosed lamp is quite economical. The connection of six lamps in series at 220 volts is no more economical than a connection of five. For small light intensities and short hours of burning, four lamps in series may be more economical than six lamps. With the flame arc, four lamps in series at 220 volts are not less economical than five lamps in series. The flame arc lamp is to be taken into consideration only for great light intensities, such as 1000 Hefner candles at 110 volts and 2000 Hefner candles at 220 volts, but for all practical conditions the flame arc is more economical than other types of lamps. The superiority of three lamps in series over two lamps in series appears only at longer hours of burning or with greater light intensity. In every respect 220 volts appears to be less economical than 110 volts for arc lamp installations. There is no difference between alternating and direct current with respect to flame arcs. Ordinarily arc lamps, however, when operated with alternating current, three in series, at 110 volts, consume about 60 to 70 per cent more energy for the same light than with direct current, three lamps in series, and 40 to 50 per cent more energy than with direct current, two lamps in series.

Brush-Holder.—The London *Electrician* contains an illustrated description of the brush-holder shown by Fig. 4 herewith. A spiral spring serves to exert a uniform pressure of the brush on the commutator and this is enclosed in a cartridge-shaped arm of the brush-holder and thus pro-

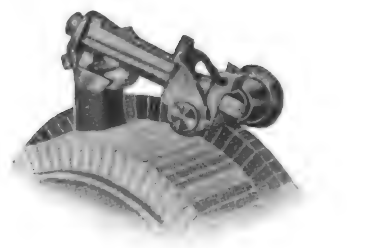


FIG. 4.—BRUSH-HOLDER.

tected from dust and accidental injury. The milled nut, *A,* serves to adjust the pressure of the spring. The latter presses against a small plunger which abuts at one end against the face of the cam, *B,* clamped to the brush spindle, *C,* while the other end of the spring passes through the hollow nut, *A.* When the brush wears away sufficiently to be of no further use, a small projection, *D,* coming in contact with the head of the plunger prevents any further descent of the brush. The metal parts of the brush-holder cannot, therefore, damage the commutator. The cam, *B,* is of such shape that the brush when lifted off the com-

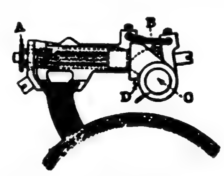


FIG. 5.—BRUSH-HOLDER.

mutator remains in this position, thus allowing any adjustments to be made and facilitating the renewal of the brush.

Direct-Current Power Transmission—In a lecture delivered before the British Association for the Advancement of Science on "The Distribution of Power," Prof. Ayrton spoke in favor of the use of high-tension direct-current for power transmission and distribution. Direct-current possesses an advantage over alternating-current in that there is less liability of breakdown of insulation, since from the point of view of economical transmission 60,000 effective volts alternating is the same as 60,000 volts direct, yet from the point of breakdown of insulation 60,000 effective volts alternating is as bad as 85,000 volts direct, and may be worse than 100,000 volts direct-current. There is, further, with direct-current, no question about self-induction reducing the current, and hence, no objection to putting the conductors as far apart as the risk of brush discharge may necessitate. There is also no question about capacity current nor resonance troubles, etc. The author also states as another advantage of direct-current transmission, as carried out by Thury, that it is the current which is kept constant and the voltage which is automatically raised when the demand for power is increased. It is easier to maintain constancy of the current flowing along a long circuit than to prevent the bobbing up and down of the voltage at the distant end of a long transmission line and "that irritating dancing of the lights." Constant current has also its well-known disadvantages, but these would not come into play if the constant current were not taken into houses, etc., but were used to drive motor-generators in sub-stations.

Some Recent Electrical Patents

Motor Controller.—Figs. 1 and 2 illustrate diagrammatically the feature of a patent recently issued to Mr. Samuel S. Neu, of New York, covering an improved motor-starter, this feature consisting of an arrangement for opening the shunt field circuit of the motor whenever the armature is shut down, the opening of the field circuit taking place after the armature has been brought to rest by the dynamic braking effect due to close-circuiting the armature with the field excited. The diagrams show two methods of accomplishing the desired result; in Fig. 1, the field circuit is opened by the lever, under the influence of a helical spring, after it has been

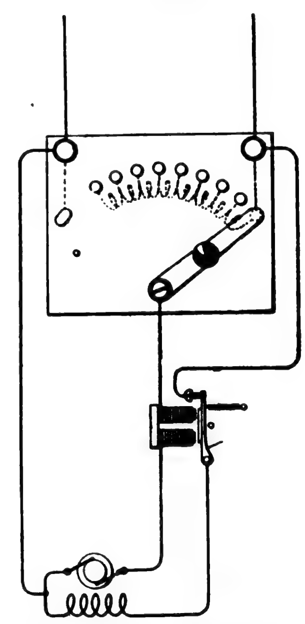


FIG. 1.—MOTOR CONTROLLER.

released by the magnet in the armature circuit; in Fig. 2, the starting arm, when thrown to the off position by its spring in the usual manner, first short-circuits the armature by resting on the contact on which it is shown in the diagram, and then opens the field circuit by moving the switch lever, *j,* away from its contact stop. In Fig. 1, the armature is short-circuited in the same way, the starting lever resting on the button, and the current flowing in the armature due to its generator action while

running on its own momentum holds the field circuit closed; as soon as the armature current dies, the magnet releases the

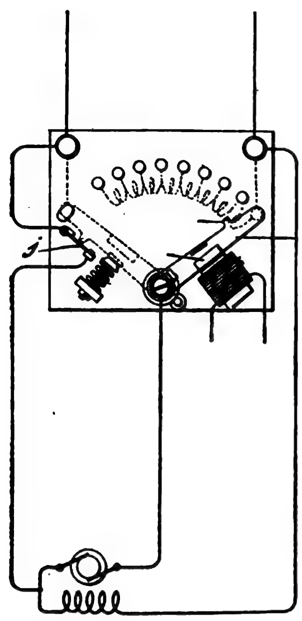


FIG. 2.—MOTOR CONTROLLER.

armature, thereby opening the field circuit. Patent No. 800,816.

Metallic Wire Conduit.—Several efforts have been made to produce a metal

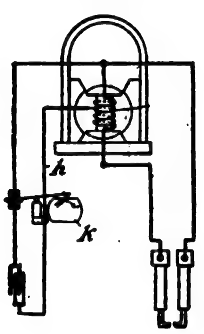


FIG. 5.

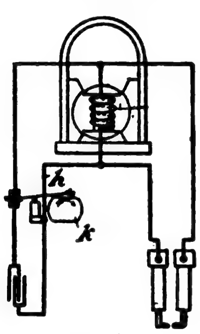


FIG. 6.

interior conduit which would have all of the mechanical merits of the old wooden moulding without its demerits from the insurance and æsthetic standpoints. The accompanying illustrations, Figs. 3 and

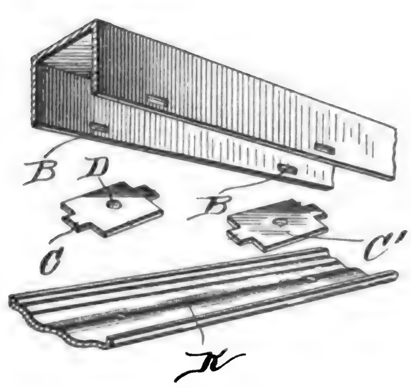


FIG. 3.—METALLIC WIRE CONDUIT.

4, taken from a patent issued to Mr. Henry C. Ayres, of Greenville, Ohio, show one of the latest of these devices. The conduit comprises a metal trough, *A*, having short slots (*B*, *B*) punched in its sides at suitable intervals; a series of shelves, *C*, having end lugs to fit in the slots, and a cover, *K*, to close the under side of the trough. The shelves support the wires, as indicated in the cross-sectional view, Fig. 4, and also provide a means of holding the cover in place, the latter being held on

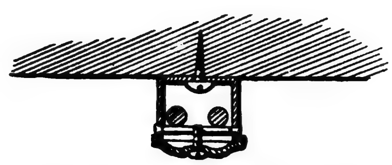


FIG. 4.—METALLIC WIRE CONDUIT.

by screws tapping into the holes *D*, *D*, in the centers of the shelves. Patent No. 800,052.

Magneto for Gas Engine Ignition.—The disadvantages of having to renew primary battery cells and recharge storage cells have stimulated inventive effort along the lines of magnetic generators for this class of service. One of the arrangements recently devised and patented by Mr. Gottlob Honold, of Stuttgart, Germany, is illustrated herewith. Mr. Honold's method consists broadly of short-circuiting the magnetic armature until the moment for ignition and then releasing the short-circuit abruptly while the armature winding is in a position of maximum activity. The contact which short-circuits the armature is bridged by a condenser in order to enhance the effect of releasing the short-circuit.

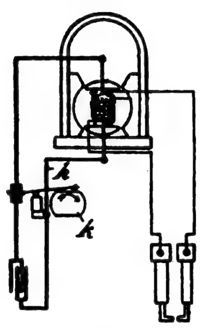


FIG. 7.

Fig. 6 shows this arrangement in its simplest form, the entire armature winding being short-circuited by the contact *h* until it is raised by the timing cam, *k*. In Fig. 5, only half of the winding is affected, and in Fig. 7 two windings are employed, one a relatively low-potential winding which is short-circuited until the ignition moment, and the other of many turns of finer wire which is connected to the igniter plug and is affected by the first winding transformer fashion. Patent No. 802,291.

NOTES.

Central Battery System "Discovered" in Germany.—The Germans have progressed telephonically to the central energy stage. The whole of the Berlin telephone network is being reconstructed and adapted to the central battery system, which has been in use in this country for many years. "The most striking feature of the new telephone apparatus," writes a correspondent, "is the absence of any crank for actuating the signalling apparatus, it being only required to take the receiver off the hook, when the current from the exchange battery lights up a small glow lamp there. By reciprocating movements of the hook, flickering signals can be produced at the exchange."

Wireless Telegraphy and the President's Trip.—The suggested plan of the President to return from New Orleans on one of the Government war vessels, keeping in touch with affairs on shore by wireless telegraphy during the four days' voyage, only furnished another illustration of the way in which electricity overthrows antiquated precedents. There has long been a tradition that no President should leave United States territory while in office, and we recall no other instance in which this has been done. In some quarters there is held the idea that the deck of a warship is Government soil, and that President Roosevelt's trip violates no tradition after all. However that may be, wireless telegraphy furnishes the means of keeping the Chief Executive's hand upon the helm with essentially the same grip which is manifested at the White House itself, so there would seem to be no occasion for alarm on the part of those who fear that the Ship of State will be striking the rocks during the absence of its Pilot from the wheel-house. It is just a neat example of remote control, which every electrician knows to be perfectly feasible.

The Fruits of Municipal Control.—A correspondent throws some light on the inner workings of electric plants under municipal control, in the following letter, names being omitted for obvious reasons:

> You may state through the columns of your paper that I have resigned as superintendent and manager of the ———— Municipal Electric Light plant and have accepted a similar position with the ———— Electric Light & Power Company. The plant at ———— while under my management was prosperous; but became involved in politics, and is fast going down hill. Mr. ———— was appointed in my place; but Poor Man! he only lasted four days; burnt out a machine, got hold of a live wire and they carried his body home on a stretcher.

According to a clipping from a local paper which our correspondent enclosed, it appears that this victim of circumstances had been employed as a fireman and engineer. His chief had asked for the munificent salary of $70 per month, and the trustees tried to hold him with a compromise salary of $65, but without avail. The fireman was then placed in charge with the above unfortunate result. The plant was shut down and the town was without light for some time. An inexperienced man finally essayed to take charge and the service has since been abominable. The clipping ends with these words: "It has been proved that trying to run thousand-dollar machinery with fifty-cent help isn't economy and one of these days the board will come to realize it."

Kansas Gas, Water and Electric Association.—The eighth annual meeting of the Kansas Gas, Water, Electric Light and Street Railway Association was held at the Mercantile Club, Kansas City, Kansas, October 13 and 14. The election of officers for 1905-6 resulted as follows: President, W. E. Sweezy, of Junction City, Kan.; first vice-president, S. W. Sterrett, of Kansas City, Kan.; second vice-president, F. D. Aley, of Wichita, Kan.; third vice-president, C. L. Brown, of Abilene, Kan.; secretary and treasurer, James D. Nicholson, Newton, Kan. The new executive committee consists of E. Springer, W. R. Morrison and J. C. Nicholson.

International Exposition at Milan, Italy.—In order to appropriately celebrate the completion of the Simplon tunnel, an international exposition under royal patronage will be held in Milan, Italy, from May to November, 1906. This will be the largest European exposition ever held outside of Paris. Every branch of art, science, agriculture and the industries will be given ample space and adequate opportunities for exhibition. The entire fair will cover an area of more than 10,764,200 sq .ft., of which one-quarter will be covered by buildings. Nearly every country in the world will be represented. The commissioners for the United States section are J. H. Gore and L. S. Ware. Mr. Gore's address is, care of George Washington University, Washington, D. C.

Illinois State Electric Association.—At the sixth annual convention of this association, held at the National Hotel, Peoria, Ill., October 5 and 6, the following officers were elected: President, D. Davis, Litchfield; first vice-president, J. N. C. Shumway, Taylorville; second vice-president, E. L. Brown, Elmwood; third vice-president, E. McDonald, Lincoln; fourth vice-president, E. H. Gray, El Paso; treasurer, W. J. Day, Bement; secretary, H. E. Chubbock, La Salle. Executive Committee—W. B. McKinley, Champaign; E. G. Schmidt, Springfield; F. J. Baker, Chicago; S. S. Davis, Moline; E. B. Hillman, Quincy.

Underwriters' National Electric Association.—The annual meeting of the electrical committee of the Underwriters' National Electric Association will be held in the rooms of the New York Board of Fire Underwriters, 32 Nassau Street, on Wednesday, December 6. As in the past, the meeting will be open to all interested in the matter of rules for the installation of electric wiring and apparatus, as contained in the National Electric Code. Reports of committees and all suggestions for changes in the code to be acted on at this meeting should be in the hands of the secretary, C. M. Goddard, by November 5, in order that they may be printed for the meeting. The secretary's address is 55 Kilby St., Boston, Mass.

CENTRAL STATION ENGINEERS—XIII.

W. W. Freeman.

W. W. Freeman, vice-president and general manager of the Edison Electric Illuminating Company, of Brooklyn, N. Y., was born in Exeter, Ontario, Canada, on June 8, 1872. He was educated in the grammar and high schools of Canada and began his business career on coming to New York in February, 1889. He became at that time stenographer and secretary to the general manager of the Edison Electric Illuminating Company, of Brooklyn. The company was just beginning operations, having obtained its charter from the City of Brooklyn but a few months prior to that date. Mr. Freeman was, therefore, the first employe of the company, outside of the executive officers, and thus became familiar with the history and the operations of the company in all its departments as the business developed and the company expanded. After serving for about two years in the capacity referred to, he was promoted to the position of assistant to the secretary and treasurer of the company retaining this position until January, 1895, when he was made assistant secretary. In January, 1898, Mr. Freeman was appointed secretary of the company and given entire charge of the conduct of the business, including the solicitation of new business, the dealings with the company's customers and with the public, in addition to executive duties. Early in January, while still retaining the office of secretary, he was also appointed treasurer, and elected a director. Last June he was elected vice-president and general manager of the company, retaining the office of treasurer, but resigning that of secretary. Mr. Freeman is also at the present time vice-president and treasurer of the Kings County Electric Light & Power Company: secretary and treasurer of the Amsterdam Electric Light, Heat & Power Company; director and treasurer of the Electrical Testing Laboratory, and president and treasurer of the Rubber Balloon Company of America. He is also a member of the Manufacturers' Association of New York, and a member of the Brooklyn Club, Crescent Athletic Club, Ridge Club, and also president of the Congregational Club of Brooklyn.

W. W. FREEMAN.

Western Association of Electrical Inspectors.—A meeting of the Western Association of Electrical Inspectors was held in the Assembly Rooms of the Chicago Underwriters' Association on Thursday and Friday, October 5 and 6. The secretary's report indicated a membership of one hundred and fourteen, sixty-six of whom are connected with municipal departments, forty-six serve insurance interests and two are employed by public service corporations not engaged in the electrical business. Since its organization the association has issued eight bulletins and seven committee reports, consisting in all of fifty-one pages of printed matter. Out of the large number of recommendations for changes in the National Electrical Code, the association only saw fit to endorse six. Several interesting committee reports covering various phases of electrical inspection work were discussed. In view of the short time permitted for the consideration of subjects allotted to special committees, the general excellence of reports submitted to the association has been a source of great encouragement to its officers and members. Four additional special committees were appointed to undertake the investigation of the following subjects: Electric crane wiring, underground systems, induction motors, and co-operation with National Electrical Associations. The next meeting is scheduled to be held at Indianapolis, Ind., in October, 1906.

Michigan Electric Association.—This association held its second annual meeting at the Griswold House, Detroit, Mich., on October 10. The papers read and discussed were as follows: "Rates," by W. F. Kingan, Detroit; "High Efficiency, High Candlepower Incandescent Lighting Units," by Francis W. Willcox, of Harrison, N. J.; "Constant-Speed Motors and Centrifugal Pumps: Their Advantage to Waterworks Plants," by P. D. Denman, Detroit; "Uniform Accounting and Its Relation to Cost Determination," by S. G. Carleton, Sault Ste. Marie, Mich.; "Electric Heating Devices," by H. W. Hillman, Schenectady, N. Y., and "Lightning Arresters," by Robert S. Stewart, Detroit. The new officers of the association are: President, William Chandler, Sault Ste. Marie; vice-president, F. S. Hubbell, Milford; secretary and treasurer, A. C. Marshall, Port Huron.

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CONTENTS.

Some Lessons from a Small Plant.

It is always interesting to inspect a plant with the idea of ascertaining at what points its production economy suffers, or of noting especially effective methods of operation. While in many cases conditions which are not apparent on the surface determine the wisdom of a design, it is generally possible to pick out various features in a given layout of machinery which should not be overlooked in other propositions. The idea prevails in some quarters that the study of old plants is of little importance in comparison with the analysis of new designs, but in the effort to secure high efficiency of operation there is surely as much profit for the engineer in examining abnormal specimens in the power station line as there is for the physician in the study of disease. That more thorough studies of older plants are needed is evidenced by the defects which are frequently permitted to appear in even the most modern installations.

A suggestive installation is the local electric light plant of a New England town of about 4,000 population. In the community served, the sale of electricity for lighting exceeds the sale of gas by the ratio of 7 to 1, and the gross earnings per capita are $5.09, a figure surpassed by few of the largest stations in that state. With such excellent receipts there should be the opportunity, of rolling up attractive net earnings by the reduction of the operating ratio to the lowest point consistent with proper maintenance. During the last fiscal year the gross earnings of the electric plant were $19,462, and the operating expenses $11,720. Of the latter, $6,425 was expended at the station. The equipment consists of two 150-h.p. boilers and 350 kilowatts of generating machine, all the units being of the old 133-cycle type, belt-driven from non-condensing engines. Such a combination certainly promises little in the way of fuel economy, and the resulting inefficiency of plant operation becomes all the more striking when the station labor account is considered. No figures are at hand covering wages, but as the power house force consists of one day man and one night attendant, their combined salaries probably do not exceed 15 per cent. of the total operating expenses. The duties of engineer and firemen are both performed by a single individual, who signals for help with the station whistle in case anything goes wrong.

The coal handling scheme in the plant is decidedly uneconomical, although one would not expect mechanical conveyors and automatic stokers in so small an installation. The point of loss lies in the needless extra labor of shoveling between the coal cars and the grates. Coal is brought to the plant in the railroad cars and shoveled upward over the sides of the cars into out-of-door bins. Three men are often employed in this work, and their wages enter into the cost per ton delivered regardless of whether they are on the railroad, the coal dealer's or the electric light company's pay roll. From the bins the coal is shoveled by the regular fireman into a hand barrow, wheeled a distance of some 40 feet to the boiler room, dumped upon the floor and finally shoveled into the furnaces. Various other faulty features of operation might be cited, but it will serve our present purpose to touch upon but two points. In the boiler room the high-pressure piping leading to the feed pump was found to be uninsulated, leading to a waste of heat, and consequently of fuel, while in the dynamo room some of the wiring was discovered to be in a bad tangle capable of causing serious trouble.

The Outlook for Heavy Electric Traction.

For certainly a decade electrical engineers have looked forward with the most intense interest to the time when the steam locomotive shall be driven from its place in trunk line service. That day may still be far ahead, but the purchase of twenty-five alternating-current locomotives at $30,000 each by the New York, New Haven & Hartford R. R. as announced at the Philadelphia Convention of the American Street Railway Association, indicates that the problem is in a fair way to be solved. The large developments in process in the terminal service at New York on the part of the New York Central and Pennsylvania lines show conclusively that the steam locomotive—admirable machine as it is in many respects—is doomed to extinction within the largest centers of population, and that the suburban service in the near future in and about progressive metropolitan circles will be handled by electricity in a manner that will be a revelation to the traveling public and a source of enlarged financial satisfaction to the directors and stockholders of the transportation companies. Now comes the New Haven with a proposition of such breadth and far-sighted departure from previous standards that our acceptance of the triumph of electricity in suburban service seems but the assured anticipation of still greater progress.

It is a matter of small significance that these new 78-ton 1,600-h.p. machines are to be operated for the present on the New York Central's direct-current lines between Woodlawn and the Grand Central station. The ability of these locomotives to operate upon both alternating and direct-current circuits is indeed an achievement of which single-phase commutating motor designers may be proud, but the key to the trunk line problem lies in the production of so large a motor as 400 horse-power, with its armature directly connected to the shaft without gearing, and multiple-unit control with alternating-current external supply in the neighborhood of 3,000 volts.

Central Station Publicity.

Methods of securing new central station business have frequently been discussed in these columns, and it is gratifying to note the progressive efforts now being made in many quarters to increase the electrical output of both large and small plants. Unless it be the question of fighting municipal ownership, there is perhaps no other matter now before central station men commanding more widespread interest than does the problem of publicity. It is certainly of sufficient importance to justify a few additional comments at this time.

The variety of ways in which a central station manager can attract public attention to his service are, of course, multitudinous. Perhaps the best advertisement of all is a quality of service which surpasses that of other communities in the same general vicinity. People are constantly traveling about from place to place in these days of automobiles and interurban electric railways, and during the hours of darkness the contrast between the well-lighted streets and stores of one town and the run-down, gone-to-seed appearance of a neighboring town served by decayed Welsbachs and sputtering gas or oil street lamps is certainly too great to pass unnoticed. It is not an easy matter to estimate the influence of first-class street and commercial lighting upon the development and prosperity of a given community, but there is no possible doubt that well-illuminated thoroughfares and buildings are essential to the lasting prosperity of any city, large or small, which is face to face with modern competitive conditions. It means a great deal to a town whether commercial travelers "size it up" as a "dead" or a "live" community, and while something besides electric lights is needed to establish and maintain a reputation for business aggressiveness, there are very few places of a solid, successful character which are served with poor illumination. We have no desire to provoke anything but friendly rivalry between central stations in the same general vicinity in suggesting that a little local newspaper emphasis of good service is sometimes worth much more than it costs. First, last and all the time, the central station manager must remember that the more the public can be brought to realize the good service it is receiving the less chance there is for the politician and the municipal ownership cranks to injure his business.

The Edison companies are doing a great deal to educate the public in the advantages of electric light and power service. In its last monthly bulletin, for example, the Boston Edison Company, brings out a number of points which ought to be generally appreciated by and brought home to the consumer. The company considers the state in which we should find ourselves if we had no incandescent lamps, but were thrust back into the gas-kerosene era, choking over the sulphurous fumes of eight-day matches, breathing the vitiated air of homes illuminated by open flames, sweltering under the heat of gas chandeliers in churches and theatres, and at night wandering along streets shrouded in darkness. To lose the incandescent lamp would be one of the greatest calamities the world could know. The company points out the decreased expense for redecorating where electricity is used and states that real estate agents testify that an electrically lighted building need not be redecorated but once in two years, at the least, compared with about twice as often in gas or oil lighted rooms. Owners are on record who allow tenants a lower rent in consideration of their using electricity instead of gas or oil. These points are well appreciated by central station managers, but that is not so much the issue as the education of the public to the more extended use of electricity. Publicity in some form is the only method of accomplishing this result.

An effective means of attracting the attention of the discriminating public consists in the employment of an architect in the erection of power plant and sub-stations. The day has passed when permanent engineering structures have any excuse for being of hideous appearance. The pumping stations of the Metropolitan Water Board, in the suburbs of Boston, have long been famous for their architectural attractiveness, and the work of the building designer in such plants as the Subway and the Kingsbridge power houses and the Waterside Edison station in New York proves that the central station may be no less architecturally pleasing than the picture gallery. The new plant of the Cambridge (Mass.) Electric Light Company is another example of the erection of a power house on the border of a superb riverside parkway, the building being in such harmony with its ultimate surroundings as to add to the landscape's attractiveness. Questions of this kind cannot be well expressed in dollars and cents, but it is certain that money expended to establish a public reputation for solidity, permanence and sagacious adaptation of means to ends is well worth while.

The power field is so vast that no central station man ought ever to be at a loss to find a suitable subject for his advertisements. All that is necessary is sufficient knowledge of different kinds of business to enable the particular advantages of electricity to be pressed home suitably in each case. Thus, in a chemical laboratory the cleanliness and compactness of the electric motor and light commend themselves, while in the large coffee and spice grinding house the ability of the motor to operate under the severe conditions of pepper and other dust needs to be brought forward. Certain advantages are common to all businesses. For example, the proper use of electricity in a formerly gas lighted store almost immediately produces a greater volume of trade, a better average class of business and freer buying attitude on the part of customers.

Finally, the application of the electric sign is a whole field in itself. In its haste to supply customers with signs a station should not overlook its own advertising. All through the territory supplied with Boston Edison current, one finds the poles each labeled with a neat tin plate marked "Edison Light" in white letters upon a black background. A drawing of a lighted incandescent lamp occupies the center of the plate, and the whole affair is so neat that its presence is permitted even in the heart of the Metropolitan Park system—a privilege which we believe is extended to no other advertiser. The Walden Electric Light Company uses an attractive illuminated sign at its offices, consisting of incandescent lamps disposed in the form of a horse-shoe magnet, with the company's name in the center. All these points count in the aggregate, and are in part responsible for the enormous extension in the use of electricity common to progressive communities.

CONSTRUCTION OF A CONDENSER FOR A JUMP-SPARK COIL.

In the October number, instructions were given for constructing a jump-spark coil for gas-engine ignition purposes, and while this coil will give good results at the terminals of the secondary when current is supplied to the primary, its efficiency is materially increased by the addition of a condenser. Such a piece of apparatus is made of tin-foil, each sheet being insulated from the next by some dielectric.

The capacity of a condenser is expressed by the formula: $C = K \div d$, in which K is a constant depending on the specific inductive capacity of the dielectric; A, the total area of the tinfoil, and d the distance between one sheet and the next. It is evident, therefore, that the capacity depends directly on the nearness of the sheets to each other and the value of the dielectric constant for the material separating them, so that the more compact the condenser, the greater its efficiency; and this should be borne in mind when assembling the condenser.

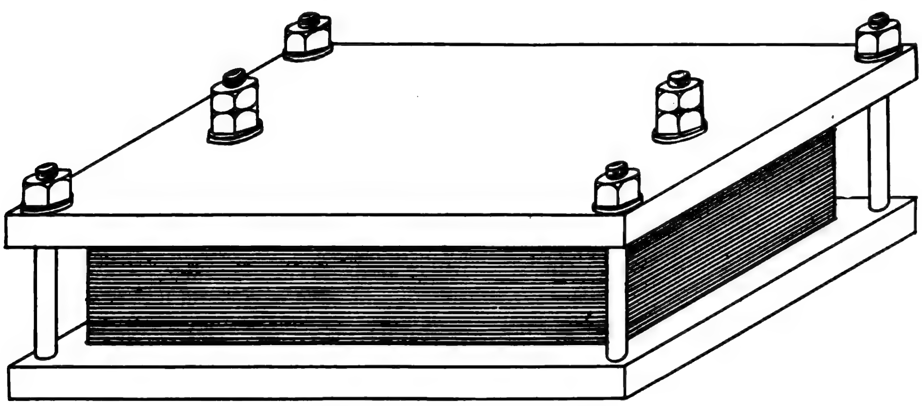


FIG. 1.—ELECTRIC CONDENSER.

A condenser suitable for the jump-spark coil described last month may be made of 60 sheets of tin-foil, 3½ ins. by 9 ins. Any other size might be used provided the area of the tin-foil in the completed coil is the same, the size given being chosen so as to enable the builder to fasten the condenser to the base of the coil. The tin-foil may be purchased from dealers in electrical instruments, or directly from the makers. Paraffined paper may be used as the dielectric, and this may be prepared by the person building the condenser. For this purpose a thin bond paper is most suitable. The sheets of paper should be a trifle larger than the sheets of tin-foil so that there will be a clear margin of about ½ in. around the edges of the tin-foil. A few more sheets of paper than tin-foil should be provided.

The paper should be carefully inspected for flaws, cracks and pin holes; these may be easily detected by holding each sheet of paper between the eye and a strong light. All defective sheets should be rejected. The selected sheets should then be dipped in a paraffin bath. Two plans may be followed in thus treating the paper. All the sheets may be laid in a flat dish such as is used in developing photographs, and some shavings of paraffin placed between each sheet with additional lumps of the substance on the top sheet. The dish may then be placed in a moderately warm oven, when the paraffin will melt and saturate the paper. If properly done the sheets of paper will be semi-transparent. This dish may then be removed and each sheet of paper lifted separately, so that any surplus paraffin may flow off. The paper should then be allowed to dry. Another, and better way so far as results are concerned, is to heat each sheet of paper so as to drive off the air and moisture and pass it through a bath of melted paraffin. The paper, which will rapidly absorb the paraffin, should then be drained of any surplus and dried.

Any one of three different methods of building the condenser may be adopted; but allowance must be made in the size of the tin-foil to suit the method. In the method illustrated by Fig. 2 the ends of the tin-foil are made to overlap the sheets of paper. Another method is to provide additional strips of tin-foil about an inch wide, for overlapping purposes, while a third method is to solder half of the number of sheets of tin-foil to a copper strip, and the other half to another copper strip, so that the two resemble books having leaves of tin-foil.

In assembling the condenser, two pieces of hard wood, preferably maple, and slightly larger in size than the paper sheets, are fitted with bolts as indicated in Fig. 1, and

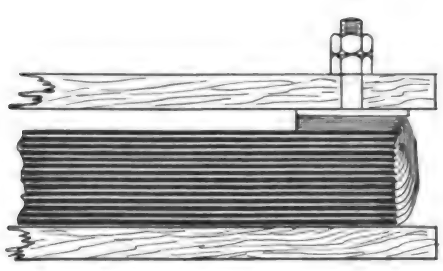


FIG. 2.—DETAIL VIEW OF CONDENSER.

the condenser is built up on the bottom piece. Two sheets of paraffined paper are laid on the wood, and in the center is placed a sheet of tin-foil overlapping to the right. Over this is placed a sheet of paraffined paper and then a sheet of tin-foil overlapping to the left. On this is placed another sheet of paper, then a sheet of tin-foil and so on, building up a pile of alternate sheets of paper and tin-foil; the latter projecting at the right and at the left alternately, until the last shee of tin-foil has been laid. On top of this are placed at least two sheets of paper and then the top part of the frame is applied and the nuts screwed down as tightly as possible.

The condenser should now be placed in a moderately heated oven, or better still on a sand bath over a Bunsen flame, care being exercised in the latter case to avoid overheating. As the paraffin melts, the bolts may be further tightened until all of the surplus paraffin is pressed out. The condenser should then be removed and allowed to cool.

When the paraffin becomes hard, the condenser may be unbolted and the projecting leaves of tin-foil bent up under the connecting bolt or binding post, as indicated in Fig. 2. This bolt should be headed with a flat piece of copper, the pressure of the corner bolts being sufficient to hold it in contact with the tin-foil leaves upon which it rests. After the top piece of wood is securely fastened, the condenser is ready for connection. One terminal should be connected to the break pillar, or mount, and the other terminal of the condenser to the break spring, or vibrator.

PRACTICAL NOTES ON BOILER FEEDING APPARATUS.

The Economizer.

BY CHARLES L. HUBBARD.

Economizers are commonly made up of vertical cast-iron pipes about 4 inches in diameter and 9 feet high, connected at top and bottom by headers. Each header is in turn connected with pipes running lengthwise, one at the top and one at the bottom, outside the brick chamber enclosing the apparatus. Each tube is provided with a geared scraper which travels up and down continuously for the purpose of removing the soot. A section of the Green economizer with its surrounding brickwork is shown in Fig. 1. The mechanism for operating the scrapers is seen at the top and may be driven by a belt from some convenient shaft or by an independent engine or motor. The feed water is forced into the economizer by the boiler feed pump at the lower branch nearest the point of exit of the gases and leaves through the upper branch pipe at the other end. The series of pipes and headers are enclosed in a brick chamber through which the furnace gases are caused to pass on their way to the chimney. The space below the lower headers is for the accumulation of soot removed by the scrapers. This soot must be removed at frequent intervals.

There are various ways of locating the economizer with relation to the boilers and chimney flue, depending upon the conditions to be met in each particular case. Dampers and flues should be provided so that the gases may be passed either through the economizer or turned directly into the chimney, in case it is desired to clean or

repair the economizer at any time. One disadvantage in the use of an apparatus of this kind comes from the fact that it reduces the draft of the chimney somewhat owing to the increased friction of the gases and also to their reduced temperature.

Provision must be made for this either by the use of mechanical draft or by providing a more powerful chimney than would otherwise be necessary. The percentage of saving by the use of an economizer will depend on circumstances, but can be determined approximately by the general formula given for feed-water heaters.

The average of nine tests reported by Mr. William R. Roney in a paper read before the American Society of Mechanical Engineers showed the rise in temperature of the feed water in passing through the economizer to be 140°, with a corresponding drop of 257° in the temperature of the furnace gases. The average saving in fuel for the same tests was 13.8 per cent. These results will of course vary somewhat in different cases. While economizers are commonly used for the purpose of reducing the cost of fuel, they are also installed in connection with existing boiler plants for increasing their capacity. The addition of an economizer is in effect adding to the heating surface of the boilers, although the additional surface cannot be rated on the same basis per square foot, owing to the reduced temperature of the gases to which

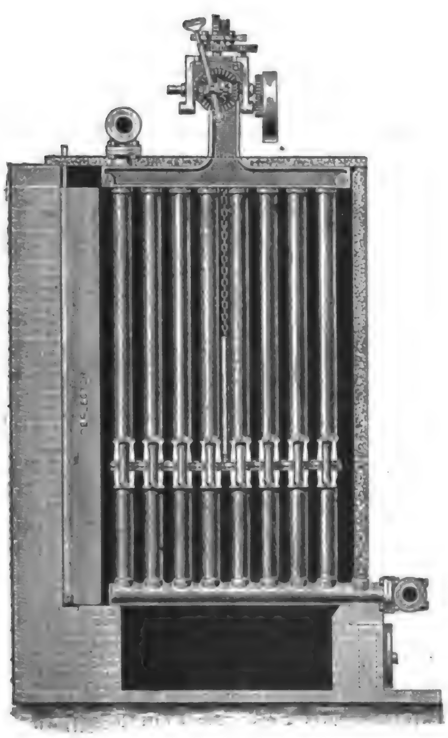


FIG. 1.—ECONOMIZER.

it is exposed. The percentage of saving in fuel by the use of an economizer may be taken as representing approximately, under average conditions, the increase in boiler capacity, should the same amount of fuel be burned as before the economizer was installed. It is customary under ordinary conditions to provide from 4½ to 5 square feet of heating surface in the economizer for each boiler horse-power.

METER TESTING EQUIPMENT.

BY R. L. ELLIS.

Some time ago the writer had occasion to design a testing arrangement for a company which had installed between 3000 and 4000 meters. On investigating the matter, he was struck very forcibly with the meagreness of detail of other boards obtainable, and this paucity of design leads him to believe that a description of the design as finally installed might prove interesting.

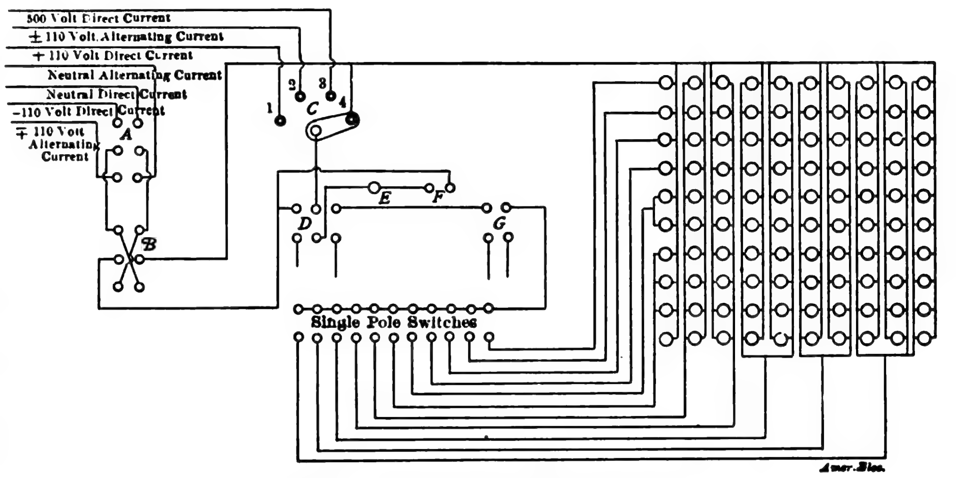


FIG. 1.—METER TESTING CONNECTIONS.

The problem was somewhat complicated owing to the fact that there were so many kinds of meters to test. There were 500-volt, 220-volt and 110-volt, direct-current meters; 220-volt and 110-volt, alternating-current meters; 220-volt, three-wire, direct-current meters, and 220-volt, three-wire, alternating-current meters, making in all seven distinct varieties.

The diagram of connections for the test board is given in Fig. 1. *A* is a double-pole, double-throw switch; *B* is a similar switch arranged as a pole-changing device; *C* is a single-pole, four-throw switch for connecting the potential leads to the meter; *D* is a triple-pole, single-throw switch with leads for connecting the test meter; *E* is a binding post for the potential connection to the meter; *F* is a similar connection for a voltmeter or the potential coil of a wattmeter, depending on which is being used; *G* is an ammeter connection, with double-pole, single-throw switch if desired. A line of single-pole switches is installed for connecting the load which is shown as a bank of lamps in the engraving. On the board as finally built the load consisted of a bank of lamps for non-inductive work, which was supplemented with motors and arc lamps when an inductive load was wanted. A feature of the board is the use of the same working voltage at the board regardless of the rated voltage of the meter under test; that is, the current going through the fields of the meter is at a potential of 110 volts always, regardless of the voltage across the potential coil of the meter.

The test of each of the different types of meter will be considered separately and the different switch positions given so as to make the operation clear. It should be borne in mind, however, that the two neutrals are grounded, as well as the negative of the 500-volt circuit, or are arranged so that they can be grounded when desired.

In testing a 110-volt, direct-current meter switch *A* is thrown up, switch *B* may be either up or down, and switch *C* is on contact No. 4. The test meter is connected at *D*, the potential coil being connected to one side of the field coil of the meter; the other side of the potential coil of the meter is connected at *E*, a voltmeter is connected at *F* and an ammeter at *G*.

In testing a 220-volt, direct-current meter, both switches *A* and *B* are thrown up, switch *C* is on contact No. 1, and the other connections are the same as when testing a 110-volt, direct-current meter.

In testing a 220-volt, three-wire, direct-current meter, the connections are the same as in testing a 110-volt, direct-current meter, with both fields in series. It should be noted, however, that this arrangement doubles the speed of the meter and consequently the constant.

In testing a 110-volt, alternating-current meter, switch *A* is down, switch *B* may be either up or down, and switch *C* is on contact No. 4. The other connections are the same as for testing a 110-volt, direct-current meter, with the exception that in alternating-current work with an inductive load a wattmeter is substituted in place of the ammeter and voltmeter.

In testing a 220-volt, alternating-current two-wire meter, switch *A* is down, switch *B* up and switch *C* is on contact No. 2. The other connections are the same as when testing a 110-volt, direct-current meter.

In testing a 220-volt, alternating-current, three-wire meter, the connections are the same as when testing a 110-volt, alternating-current meter with both fields in series. The constant is doubled in this case, as in that of the 220-volt, three-wire, direct-current meter.

In testing a 500-volt, direct-current meter, switch *A* is up, switch *B* down, switch *C* on contact No. 3, and the other connections are the same as when testing a 110-volt, direct-current meter.

While the board described may not have the best possible arrangement, it was most convenient for the particular conditions met with in the case under discussion.

THE KELLOGG COMMON-BATTERY TELEPHONE SYSTEM.

BY W. S. HENRY.

The telephone system installed in one of the Keystone Telephone Company's exchanges in Philadelphia by the Kellogg Switchboard & Supply Company is shown in the accompanying diagram. At the subscriber's station, when the receiver rests on the hook, the bell and condenser are in series across the two-line wires, and hence the bell can be rung by the ordinary alternating current used for ringing purposes. The receiver is short-circuited, and the transmitter, *T*, and an impedance or choke coil, *I*, are on open circuit. When the receiver is removed from the hook, the impedance coil and transmitter are connected in series across the two-line wires. In parallel with the impedance coil is a circuit containing the condenser and receiver. Current from the central office battery cannot flow through the receiver on account of the condenser in series with it, but it can readily flow through the impedance coil and transmitter, little or none of it passes 25 ohms, is designed to allow the transmitter to receive the requisite amount of current from the central office battery to properly operate it. The higher frequency voice current arriving from the line passes through the condenser, receiver and transmitter, little or none of it passes through the impedance coil, because it offers on account of its inductance, a much greater opposition to such a current than the condenser and receiver. Talking into the transmitter produces a rapid fluctuation in the strength of the battery current in the line circuit, thus affecting the distant telephone.

The exchange circuits operate as follows: When the receiver rests on the hook the condenser in the subscriber's instrument prevents the flow of battery current through the subscriber's telephone; but when the receiver is taken off the hook, sufficient current flows from battery $+B'$ through $g - g'$ $- T - I -$ line relay $LR - B'$ to cause LR to attract its armature, thus causing the line lamp, *L*, to light. The operator replies by inserting the answering plug, *AP*, in the proper jack and closing the listening key.

Current will flow from *B* through *g* — cut-off relay, *CO* — sleeve side of circuit —relay *SA* back to *B*, which causes the 500-ohm cut-off relay *CO* to attract its armature, thereby cutting out the line relay, *LR*, which in turn extinguishes the line lamp and also connects the two-line wires to the jack. Current can now flow and close both the supervisory relays, *SA* and *ST*, because the line circuit is closed at the subscriber's instrument. The closing of the relay, *ST*, opens the circuit through the answering supervisory lamp, *AL*, and thus prevents the lighting of the latter at this time. The operator can now communicate with the subscriber. The operator's receiver and a condenser are connected in series across the cord conductors, but there is also a condenser, *CC'*, in each cord conductor between the operator's head set and the subscriber's line circuit.

The operator proceeds to complete the connection by touching the tip of the calling plug, *CP*, to sleeve, *s*, of the jack belonging to the line wanted. If the line is busy, due to a plug being in a jack of that line at some other section, a click will be produced in the operator's receiver in the following manner: Current flowing from a battery through a 100-ohm relay — sleeve side of some cord circuit — sleeve, *s*, — tip, *t'* of calling plug — *a* — 5,000-ohm test relay, *R*, to ground, causes *R* to close its circuit, which short-circuits the impedance coil, *I''*, thus producing a sharp increase in the current through the primary, *p*, which causes a click in the operator's receiver. The operator then informs the waiting subscriber that the line called for is busy. If the line is not busy, *s*, as well as *t'* will be at the same potential as the ground; relay *LR* will not be affected and no click will be produced. If the line is not busy, the operator inserts the plug in the jack, which will operate the cut-off relay, *CO'*. She then opens her listening key and closes her ringing key.

Current now flows from *B'* through the ground — cut-off relay, *CO'* — sleeves, *s*, of jack and plug — resistance, *r*, back to battery, thus holding the cut-off relay closed while the ringing current flows from the generator through the tip side of the line—subscriber's bell and condenser—sleeve side of line—resistance, *r*—battery *B'*—ground to generator. When the ringing key is released, current flows from *B'* through ground—cut-off relay, *CO'*—sleeve, *s*, of jack and plug—relay, *SC*—back to battery,

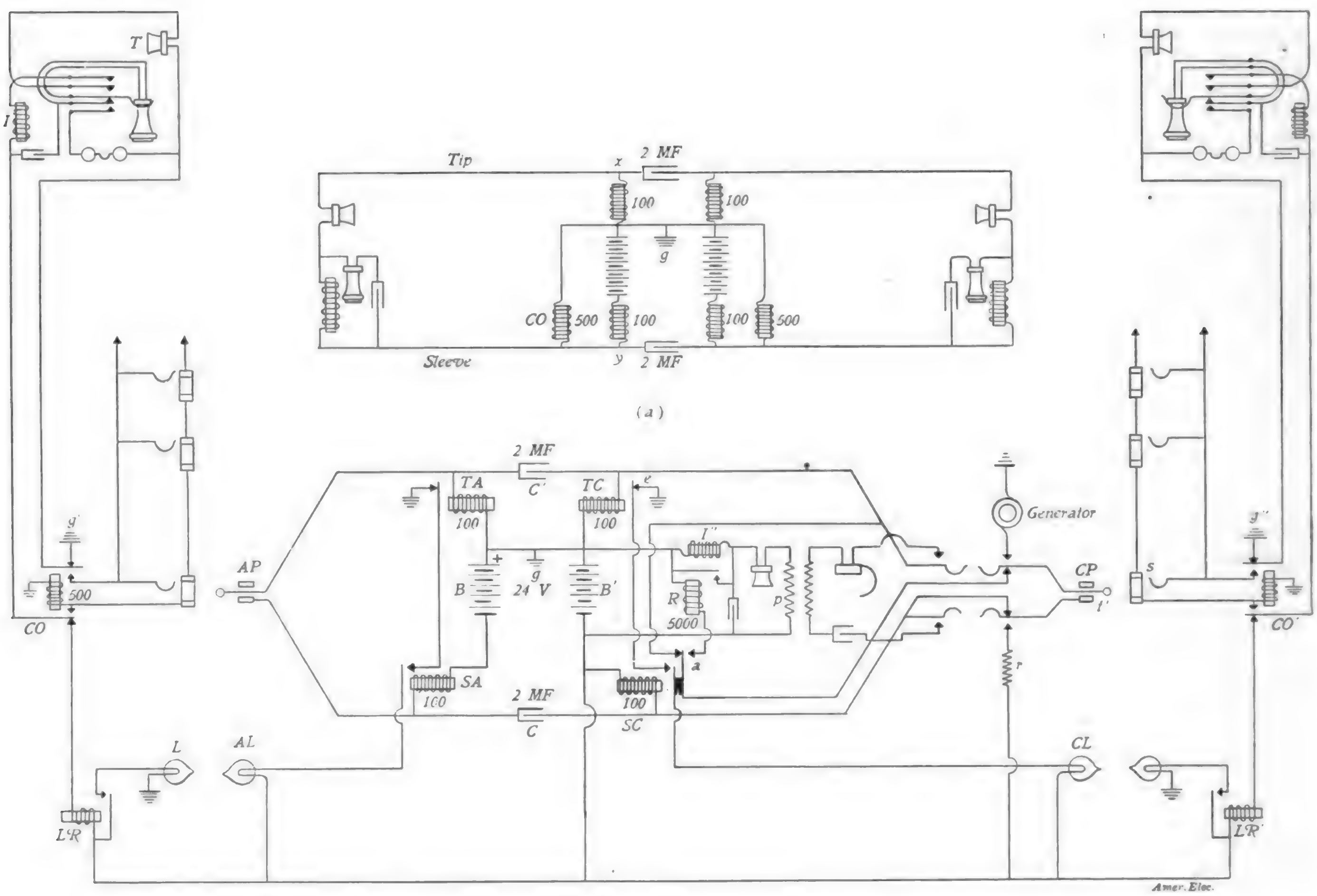


FIG. I.—KELLOGG COMMON-BATTERY TELEPHONE SYSTEM.

which keeps both relays, *CO'* and *SC*, closed. The closing of *SC* causes current to flow from *B'* through ground —*e*— calling supervisory lamp, *CL* (which it causes to light) to battery. The lamp, *CL*, will remain lighted until the subscriber called takes his receiver off the hook. Current can then flow from *B'* through relay, *TC*—*t'*—tip side of line—subscriber's transmitter and impedance coil—sleeve side of line—*s*—relay, *SC*—back to battery. This causes the relay *TC* to close, thus opening at *e* the circuit through the calling supervisory lamp, *CL*, which is an indication to the operator that the called subscriber has answered his telephone call. All three relays—*CO*, *SC*, *TC*—are now energized, and the condition of the circuit while the two subscribers are holding a conversation is shown at (*a*).

It will be seen from this diagram that each subscriber's circuit is supplied with current from a separate battery, there being a 100-ohm relay, which also acts as an impedance coil, between each terminal of each battery and the line wires. The battery and one of these relays on each side of the cord circuit are shunted by a 500-ohm cut-off relay whose resistance is sufficiently high not to deprive the line circuit of all the current necessary for the operation of the transmitters, and yet not too high to cause this 100-ohm relay to open when the receiver rests on the hook switch.

As stated, each subscriber's transmitter receives current from a separate battery through two inductive resistances, that is,

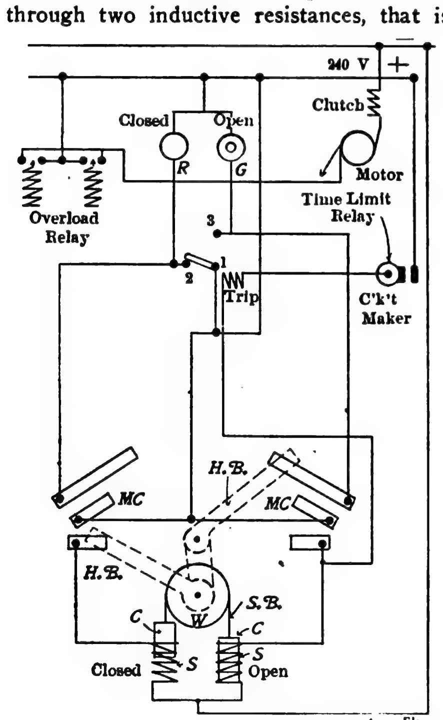


FIG. 3.—CONNECTIONS FOR STANLEY-G. I. SWITCH.

relays. A fluctuation of current in the original subscriber's circuit produces a similar fluctuating difference of potential between points, *x y*, which will produce a fluctuating charge upon the two condensers, *C C* which will, in turn, produce a fluctuating flow of current through the called subscriber's circuit.

When the subscribers hang up their receivers, the supervisory relays, *TA* and *TC*, are deprived of current and hence release their armatures, which cause the supervisory lamps, *AL* and *CL*, to light, thus notifying the operator that she should pull out the plugs, which restores the circuit to its normal condition.

HIGH-TENSION, CIRCUIT-BREAKING DEVICES.

BY W. T. FERNANDEZ.

The improved type "H" high-tension oil switch is quicker in action and more reliable than the type "H" switches previously described. The mechanical features have been improved so as to eliminate the possibility of "pumping" and by rendering

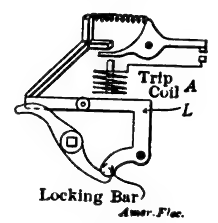


FIG. 1.

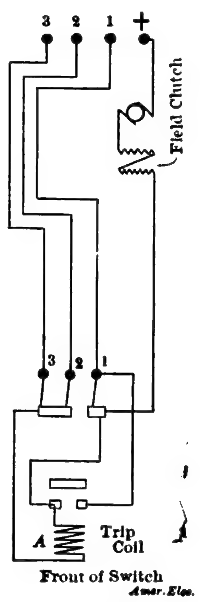


FIG. 2.

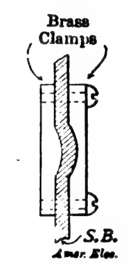


FIG. 4.

the mechanism more rapid in its action, prevent to some extent the formation of explosive gases in the oil pots when the switch is opened under load or short-circuit conditions. The added improvements are illustrated in Fig. 1. *A* is a solenoid which releases the locking device, *L*, and permits the driving mechanism to operate when the operating current is applied, as follows: When the control switch is thrown in, the motor, clutch coil and locking solenoid *A* are energized at the same instant, with the result that the locking device is released and the motor drives the switch home; the mechanism is then locked and cannot return to its first position until the control switch has been thrown in that direction. The diagram of control connections for the type "H-3" switch is the same as for the other types of "H" switches, but the frame wiring is different and is illustrated in Fig. 2. As the crank shaft is locked when it arrives at either the open or closed position, cam adjustment is unnecessary and the only attention the switch requires is oiling at regular intervals in addition to regular cleaning.

The control connections of the solenoid type of main-line switch manufactured by the Stanley-G. I. Electric Manufacturing Company are illustrated in Fig. 3. The driving power is furnished by the solenoids *SS* and taken up by dash-pots at the end of the switch's travel.

It will be seen that the soft-iron cores, *C*, which are attached to the steel band, *SB*, which is in turn attached to the crank wheel, *W*, may move freely in the solenoids and thus turn the crank shaft through an angle of 180 degrees, resulting in throwing the circuit contacts either into or out of the oil-pot contacts.

The headboard switches, *HB*, correspond to the movable fingers of the G. E. type "H" switch and are actuated by the crank shaft, so that the operating circuit is automatically shifted from the coil last used to the coil to be used in the next operation of the switch.

It will be found with this type of switch that the automatic switch, *HB*, will sometimes stick, thus causing the oil switch to pump. This condition may be brought about by several causes; the contact clips may be too tight, the headboard may be out of line, or the dash-pots may be defective in operation. The "pumping" effect may be eliminated to a great extent by disconnecting the master clips, *MC*, but the cause of the trouble should always be located and repaired before the switch is again put in service. If the clips are too tight they should be spread apart; the headboard should be lined up and the dash-pots examined. The rawhide washers may sometimes become dry and bind on the sides of the pots, or if the switches are located where there is considerable variation in temperature, the washers will become stiff in cold weather and bind on the sides of the pots, seriously affecting the operation of the switch. It will be found advisable to remove the washers and rub them well with graphite; this will result in reliable operation.

The automatic switch should be lubricated with vaseline at regular intervals, so that it will not bind on the contact clips. Another cause of trouble is the breaking of the steel bands, SB, at the point where they are riveted around the pin of the cores. This trouble may be obviated by substituting for the rivets the style of clamp shown in Fig. 4. The solenoid coils are wound for a momentary application of current, so that failure of the automatic switch to operate promptly will cause these coils to heat up and eventually to burn out. The control switch lights indicate when the automatic switch sticks, for if the control switch is thrown into the "close" or "open" position and the signal lights indicate an opposite position, it is evident that the automatic switch is sticking and requires immediate attention to prevent the burning out of the solenoids. The moving parts should be oiled at regular intervals and the mechanism of the switch kept absolutely clean, to insure effective operation.

In addition to the above described types of main line switches, there is used for individual machines, and in some cases, small feeders, a type "K" hand and solenoid-operated switch, as illustrated in Fig. 5. It must be remembered that whereas the

G. E. and Stanley-G. I. main-line switches have a total break of twenty-eight inches in oil, the type "K" has a break of but eight inches, and is, therefore, limited in its capacity to about 600 amperes under short-circuit conditions, and should be equipped with a limit relay in addition to the regular time-limit device as mentioned in a former article.

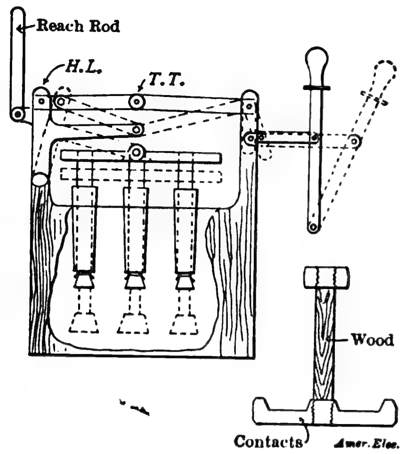


FIG. 5

Fig. 5 illustrates the mechanism of the type "K" switch, in which the toggle joint, *TT*, is operated by the lever, *HL*, or by the mechanism shown in Fig. 7 (G. E.) and in Fig. 8 (Anderson). Both mechanisms are of the solenoid type and consist of a "close" and "open" coil, actuated by direct current from a control switch similar to that used with the main-line switches.

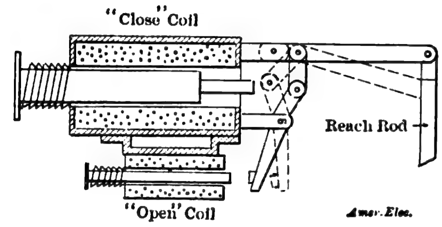


FIG. 7.

On the switch mechanism the principal parts to be watched are the bolts holding the toggle mechanism together, as this type of switch opens by gravity and not by a power drive as in the main-line types.

Where the solenoid mechanisms are used, the adjustment of the reach rod, which extends from the mechanism to the switch proper, should be marked after it has been properly adjusted, and inspected at regular intervals thereafter so that any slacking of that rod may be promptly noted and repaired. As a precautionary measure, the oil should be changed in all switch compartments once every year, and immediately after a switch has been opened under a short-circuit, as the oil will be found to be greatly carbonized and unreliable for future use.

The oil removed from the pots once a year may be filtered through a felt filter and used again, but all oil taken from switches which have opened under short-circuit conditions should be discarded at once, as the retention of it in a switch will invite an explosion if the same switch should open a second time under short-circuit conditions.

Oil-switch mechanisms should not be tinkered with by the entire station force; they are accurate mechanisms and require the attention of a mechanic who knows what he is doing. Promiscuous experimenting with them may result in one of three things —an injured man, a feeder thrown off under load, or a "pumping" switch which will damage both itself and the machine attached to it.

NOTES ON WATER COLUMNS.

BY W. H. WAKEMAN.

The principal reasons for the extensive use of water columns on tubular boilers and others which might be operated by separate gauge cocks, is that not so many holes in the heads are required, and because a water column may be located in any convenient and near-by place, whereas gauge cocks must be on the boiler front.

Under the old plan of separate connections, where three cocks and a water glass were used, it required five holes in the boiler, but a water column calls for only two holes, even if four cocks are used. The natural consequence is that the two holes are made larger in diameter, although not necessarily so. One advantage of larger holes and connections is that they are not so easily choked with sediment and scale. A possible disadvantage of water columns in general is found in the fact that if the lower connection does become filled with sediment, it prevents the use of both cocks and water glass; but owing to the location of the upper connection above the water line there is little danger of this obtaining.

As these connections are usually made of 1¼-inch pipe it requires considerable sediment to entirely fill them, but as some men seem to think that it is seldom necessary to blow them out, it is a wonder they do not become useless. A competent engineer will have this important matter attended to every day. Whether this entails trouble or not will depend on the care with which the drip pipes were located. If a ¾-inch nipple were screwed into the settling chamber of the column, followed by a valve and a short nipple, muddy water will be blown out on the floor every time an effort is made to secure free circulation through the pipes.

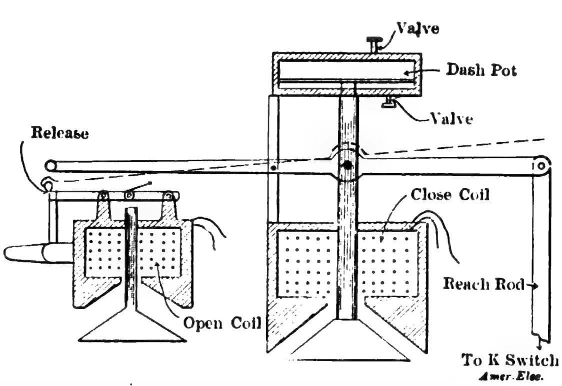


FIG. 8.

In some cases the drip pipe is continued into the ash pit, consequently when the valve is opened light ashes are blown out into the room and in rising cover the boiler front, entailing some labor in cleaning it. In either of the above-mentioned cases the natural tendency is either not to open the drip valve, except at long intervals, or to shut it quickly whenever it is opened.

Water and sediment may do no harm on the boiler room floor, and a boiler front covered with ashes will not prevent the boiler from evaporating water, but engineers and firemen seldom relish such a state of affairs, although some of them had rather endure the dust and dirt than spend the time necessary to remove them.

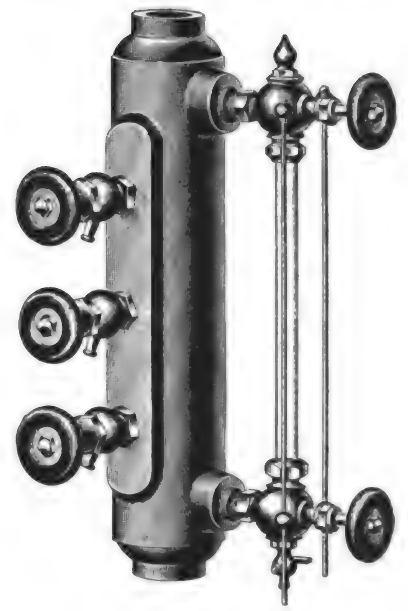


FIG. 1.—WATER COLUMN.

It is much better to remove the cause, or what is still better, never let it come into existence. This can be accomplished by continuing the drip pipe down to and underneath the floor, then carrying the discharge pipe to the sewer, or to a cesspool made for the purpose, if a sewer is not available. Under these conditions there is absolutely no excuse for allowing these connections to become choked with sediment, and there is no real good excuse for it under any other conditions.

In a certain boiler room there are five of these columns connected in this way, and they are always in good order, causing no trouble whatever. Of course all of the drip pipes are connected into one common discharge pipe to the sewer, but no other pipe is connected into it.

At night the valves in both upper and lower connections are closed while the drips are left open. If an attempt is made the next morning to blow out the lower connection to No. 1 column without shutting the drip valves on the others, muddy water is blown up into the other columns, but this is easily prevented by first closing all of these drip valves except No. 1 and then opening each in turn when it is wanted.

Brass pipe is extensively used for connecting water columns, but it is not approved by all boiler inspectors, as it sometimes fails under pressure. When subjected to changes in temperature it expands and contracts more than the iron and steel heads or shells into which it is fitted, hence leaky joints result, and this always means corrosion that weakens the metal until it is no longer safe under high pressures.

Extra heavy iron pipe is recommended by these inspectors, and their advice is usually worthy of adoption. They examine boilers operated under a great variety of conditions, and are, therefore, competent to advise in such matters.

All threaded joints in such work should be fitted so that nearly all of the threads will be covered; for where several are exposed to view it generally denotes a weak joint. Where connection is made into a boiler head about one-half inch thick, all threads on a 1¼-in. pipe cannot hold in the metal as it is not thick enough, but the surplus should appear on the inside, for if the pipe is only flush here, several must be exposed to view on the outside, and this is not the best kind of joint, because a pipe is weak where a thread is cut on it, therefore it should be well screwed into the head. The same reasoning applies to the top connection into the shell.

Brass unions with ground joints are frequently used on these pipes, but observation of many plants shows that these unions leak just enough to cause corrosion where it is least expected. On one battery of boilers the writer removed these unions, which were put in when the plant was installed, and the change made a great improvement. The column was made in two pieces and bolted together, hence it was equal to a flange union. These have needed repairs but once in more than ten years, which is fortunate because the absence of unions makes it more difficult to remove them.

On another battery the unions were retained because iron columns for supporting the floors above were near the boiler fronts, making it inconvenient to remove and replace bolts and nuts. As these have needed repairs on several occasions the unions were useful.

An angle valve in the top connection and a cross valve in the lower connection make it possible to remove the bonnets when cleaning boilers, thus securing a straight passage into the connecting pipes for removing any scale that may have collected at these points. The nozzle of a hose may be inserted, and when water is turned on the pipes are quickly cleaned.

Water columns may be divided into two classes: those without extra fixtures, and those which are fitted with high and low-water alarms. Many engineers do not object to these latter water columns when new boilers are installed, but later one oftentimes finds that if the water level should fall to the center of the shells or rise to the top of them, no warning whistle would be heard, and this state of affairs denotes the worst kind of opposition. The whistle with which each water column was originally provided had been removed and a cap put on in its place. If one should inquire concerning the cause of such action the reply is usually that it was always blowing and the engineer was tired of hearing it. When this appliance is properly installed and kept in repair, the whistle never blows except when there is good reason for it, and its removal is a clear indication that affairs are not properly managed. Very few men are willing to admit that the water level ever gets low enough to injure the boiler, or high enough to wreck the engine, yet some of them will not permit an appliance to be used that will blow a whistle when the danger line is approached.

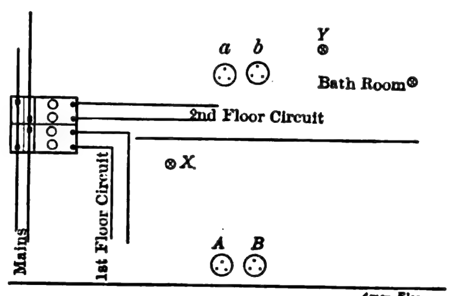
The worst fault that the writer has found with these columns and fixtures is that one or both of the floats become partly filled with water and fail to operate. If it is the upper one it will not sound an alarm when too much water is pumped in, and if it is the lower it causes the whistle to blow continually. The remedy is to have extra floats on hand so as to replace a defective one without delay.

Letters on Practical Subjects

Communications intended for publication in this department must be received at this office not later than the 15th of the month prior to the date of publication.

Problem in House Wiring.

An old house had been wired for electric lights and the floors replaced and carpets



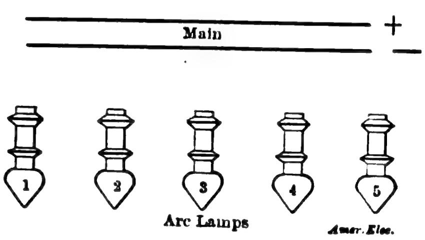
PROBLEM IN HOUSE WIRING.

laid before the lighting service was connected. When the current was turned on the light in the first floor hall and the light in the second floor hall, both of which were controlled by a pair of three-way switches, refused to light properly. With the switches in a certain position all the lights would burn at their full candle-power. Turning switch *A* extinguished light *X*, turning switch *B* extinguished lamp *Y*; turning switch, *A*, lighted lamp, *X*, and a lamp in the second floor bath room in series; turning switch, *B*, caused the lights, *X*, *Y*, and the bath room light to merely burn dimly. Two circuits were provided, one for the first floor and one for the second floor. I searched for a long while to locate the trouble, and am interested to know whether any of your readers can surmise what the trouble was.

Scranton, Pa. H. F. Hartman.

Problem in Arc Lamp Wiring.

I submit the following problem in arc lamp wiring to your readers for their consideration. Five series arc lamps requiring 35 volts each, are to be connected to a 105-volt circuit so that three will be burn-



PROBLEM IN ARC LAMP WIRING.

ing at one time, the center lamp being connected to each group, or in other words, it is required to connect lamp No. 3 so that it will burn with either lamps Nos. 1 and 2, or with lamps Nos. 4 and 5.

Paterson, N. J. M. Simon.

Mr. Riggs' Problem in Telephone Signalling.

It was discovered, but unfortunately too late to be rectified, that the first two solutions published last month to Mr. Riggs' problem are inadmissible. With the connections as shown the bells would ring continuously, and with the batteries connected in opposition the bells could not be made to ring at all. The other solutions are correct.—Editor.

The Hayes Telephone System.

Referring to the correspondence published some months ago on the Hayes telephone system, I would like to add the following additional remarks. As was pointed out before, the operator's telephone set is practically the same as a subscriber's telephone circuit, and is affected the same by separating from it the condenser, which is wired in shunt to the transmitter and coil. While the condenser keeps the line free from leakage or shunts, it more than assists in transmission. The condenser gives the side tone so necessary for long-distance transmission, in common battery operation. When subscribers object to this side tone (increased sometimes owing to

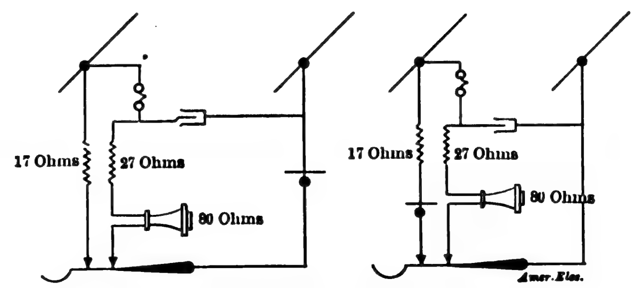


FIG. 1.—HAYES TELEPHONE SYSTEM.—FIG. 2.

the nearness of the instrument to the central office whereby it receives an abnormal supply of current) relief is given by changing the position of the transmitter, thus eliminating the condenser effect. The transmitter being in series with the line the current does not fluctuate with the vibrations of the transmitter. The repeating coils in the office, the cable, etc., all act to retard, and there is a drag to the transmission which impairs the effectiveness of long-distance work. With the condenser in circuit, energy is stored up which induces an alternating current in the 17-ohm winding and thus in the line. This current being of low amperage, is not retarded to the same extent. Fig. 1 shows the regular connections and Fig. 2 shows the connections without the side tone.

Philadelphia, Pa. W. A. Loveland.

Alternating Current Power Measurement.

I enclose a wiring diagram for the solution of the problem in alternating-current power measurement which was inserted in the August number of the American Electrician. Of the several answers published in the October number, none, in my opinion, is correct. One answer attempted to give a method to obviate the difficulty of using three meters. The problem, however, was to use three meters. This method has been used here with success, and in one case there is a polyphase meter on the same circuit with the three separate meters and the two registrations are almost identical. Referring to Fig. 1:

$E'' = \sqrt{3}\, E' \div 20$, where ratio of power transformer is 20 to 1.

$I'' = I' \div k$, where k is the ratio of the current transformer.

$W = I' E' \sqrt{3}$, or the total power of the three-phase circuit.

$W' = I' E' \div \sqrt{3}$, the power to be measured by one meter.

$W''' = I'' E''$, or the actual power measured in one meter.

$$\frac{W'}{W'''} = \frac{I' E'}{I'' E'' \sqrt{3}} = \frac{20\ k}{3},$$ constant of the meter.

The working diagram of connections is shown in Fig. 2.

Oakland, Cal. S. J. Lisberger.

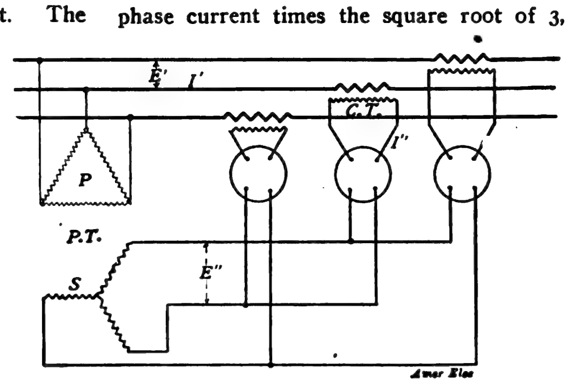


FIG. 1.—MR. LISBERGER'S SOLUTION.

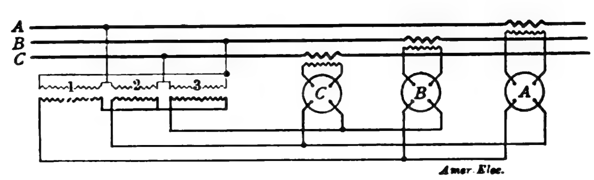


FIG. 2.—MR. LISBERGER'S WORKING DIAGRAM.

Mr. Munson's solution to Mr. Lisberger's problem published last month contains an error in the development of the meter constant. In his solution the current transformers each receive the resultant of the phase current times the square root of 3, or 1.732. The constant, 1600, should be divided by $\sqrt{3}$ in order to obtain the correct power, and this constant would be the same as that given in Mr. Umstead's solution, a very unwieldy figure. In order to get an even constant, the meters should be connected as shown in Fig. 3 herewith. The primary coils of the potential transformers are connected in star. Each coil would therefore receive $2{,}300 \div \sqrt{3}$, or 1,330 volts. Each wattmeter would then receive 133 volts and the constant would be 160×10, or 1,600. The sum of the reading times 1,600 would give the power in the system.

York, Pa. Carl E. Freeman.

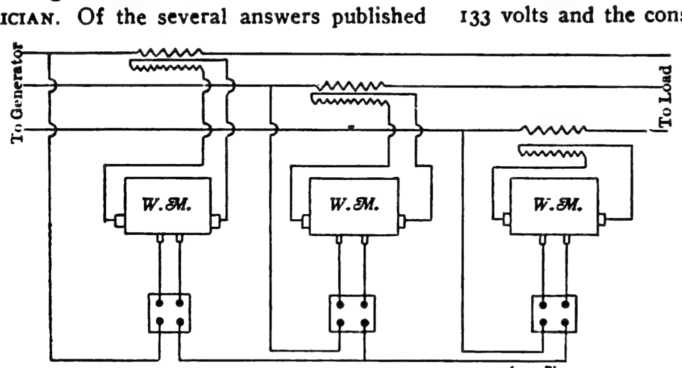


FIG. 3.—MR. FREEMAN'S SOLUTION.

[Of the various solutions offered, only one—Mr. Freeman's—complies fully with the requirements, although Mr. Sweetnam's solution published last month shows a correct method for measuring the power with two, instead of with three wattmeters. The several writers, including Mr. Freeman in his discussion of the solutions offered by Mr. Munson and Mr. Umstead, have failed to recognize the fact that if the current in the series coil is I, and the electromotive force across the shunt coil is E, the reading of the wattmeter need not always be IE. Even when the load is non-inductive, in the solutions suggested by Mr. Munson and by Mr. Umstead the current in each meter would be electrically displaced from the e.m.f. of the potential coil by 30°, or a constant of $\cos 30° = .866$ would have to be introduced. Since $\cos\,(30° + \theta)$ is not always equal to $.866 \cos \theta$, it is impossible to assign a "constant" for the connections suggested when the power-factor of the load ($\cos \theta$) is variable. In other words, the solutions given by Mr. Munson and Mr. Umstead are fundamentally incorrect.—Editor.]

Telegraphing With Open Circuit Batteries.

I note in the October number a scheme for telegraphing with dry cells or any open circuit battery. Enclosed is a sketch, Fig. 1, of another scheme which dispenses with the three-way switch, and only requires one wire, if a good return is used. Referring to Fig. 2 it will be noticed that a back contact for the key is used, and this is insulated from the frame. The circuit closing switch should be removed from the keys. If the same number of cells are used at each end and are connected so that when both keys are depressed they will oppose each other, one station can "break" the other by depressing the key. The back contact for the key can be had by shaping a piece of tin 1 in. by ½ in., as shown at R in Fig. 2, and fastening this to the table by means of a screw. It will be necessary to put a small piece of paper between this back contact and the frame of the key.

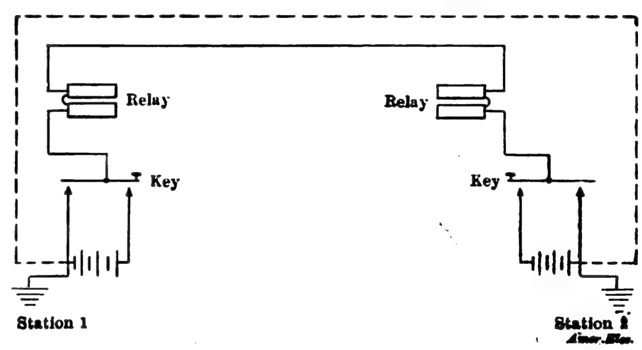


FIG. 1.—TELEGRAPHING WITH OPEN-CIRCUIT BATTERIES.

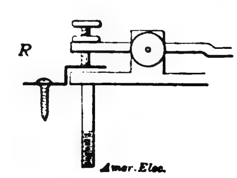


FIG. 2.—BACK CONTACT.

Paris, Texas. M. D. Hockler.

When I came across Mr. Jackson's method of telegraphing with open circuit batteries published in the October number, it brought to mind a piece of apparatus which I once made use of to obtain the same results. The difference between my method and Mr. Jackson's, is that in his, the connections are similar to those used in intercommunicating telephone systems and require an extra line wire for each station; whereas in mine, use is made of the ordinary connection of the instruments on one line. Regular telegraph instruments are used and the key is changed, as shown in Fig. 3. A piece of brass insulated from the base is placed under the regulating thumb screw

at the back end of the lever. The general connections of the instruments and line are given in Fig. 3 and Fig. 4 shows how they are connected when mounted on a wooden base. A serious drawback to this arrangement is that each station has to depend upon its own battery to supply the current for all of the instruments on the line.

Tallahassee, Fla. H. S. WHITE.

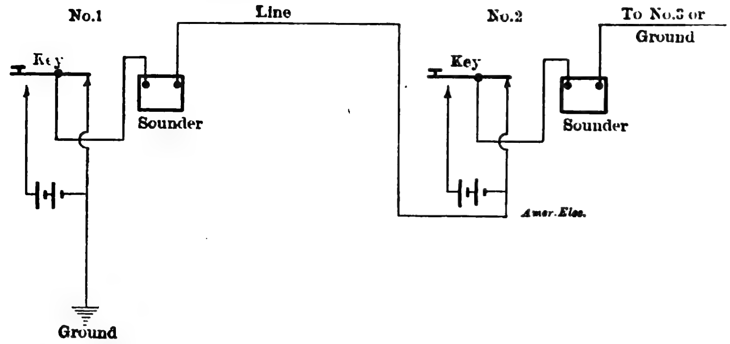


FIG. 3.—TELEGRAPHING WITH OPEN-CIRCUIT BATTERIES.

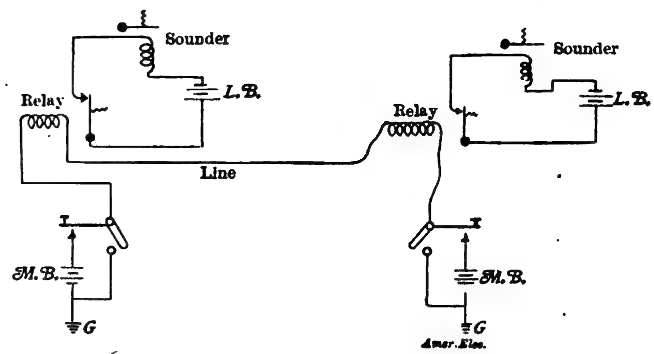


FIG. 6.—TELEGRAPHING WITH OPEN-CIRCUIT BATTERIES.

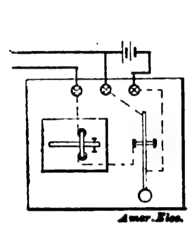


FIG. 4.

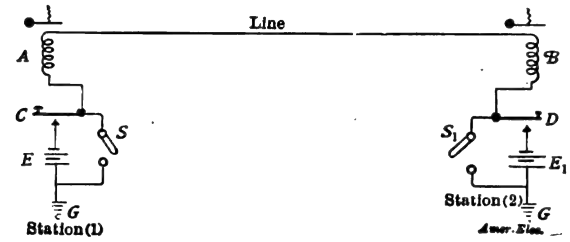


FIG. 5.—TELEGRAPHING WITH OPEN-CIRCUIT BATTERIES.

Seeing Mr. R. C. Jackson's letter in the October number on telegraphing with open circuit batteries, I beg to offer the enclosed solutions which I think are better and more practical, especially for lines of any great length. Fig. 5 shows an arrangement consisting of two sounders, A and B, keys C and D, switches S and S_1 batteries E and E_1 one line wire and two ground connections for use on short lines. When the line is not in use, switches S and S are closed, grounding the line at both ends. When Station I desires to signal Station II, the switch S is opened, thus clearing that end of the line. When the key, C, is depressed, current flows from the battery E through key C, sounder A, line sounder B, switch S to ground G and back to battery E. Fig. 6 shows the same system equipped with relays and local batteries.

San Francisco, Cal. J. J. MARSHALL.

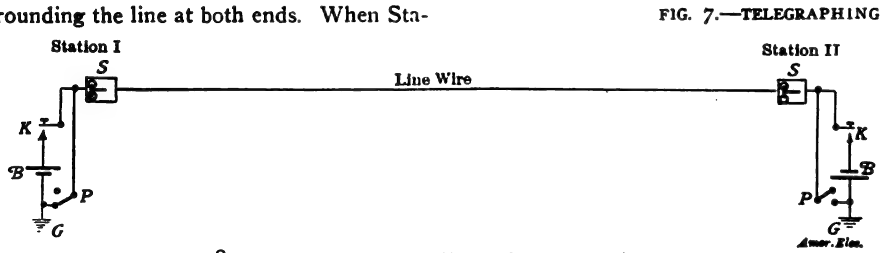


FIG. 8.—TELEGRAPHING WITH OPEN-CIRCUIT BATTERIES.

Enclosed is a diagram (Fig. 7) of a method for telegraphing with open circuit batteries, which is in some respects similar to the method published in the October number of the AMERICAN ELECTRICIAN. The scheme may be used for any number of stations; but each station must have a battery of sufficient strength to work the line. The operator wishing to use the line, moves the three-pole switch so as to put his battery on the line. The line may then be used as an ordinary closed circuit line, the operator throwing his switch back again when finished. I have used this scheme on a three-station line for several months and find it very satisfactory, the expense for battery being slight.

Glen Ellen, Cal. P. M. QUIEN.

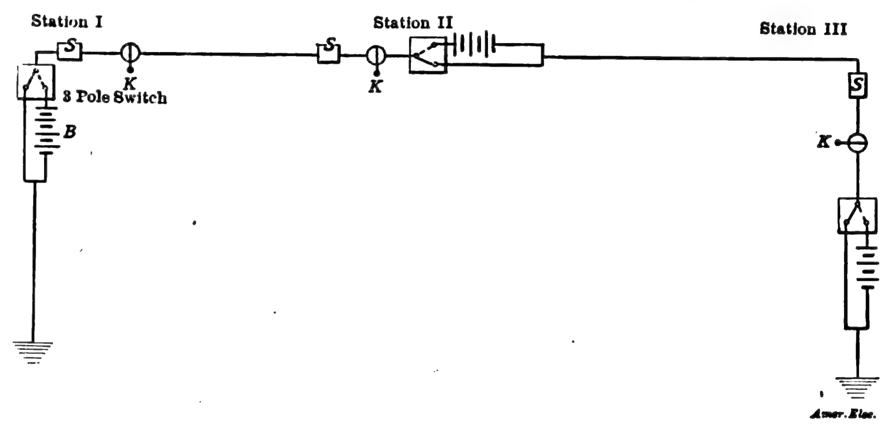


FIG. 7.—TELEGRAPHING WITH OPEN-CIRCUIT BATTERIES.

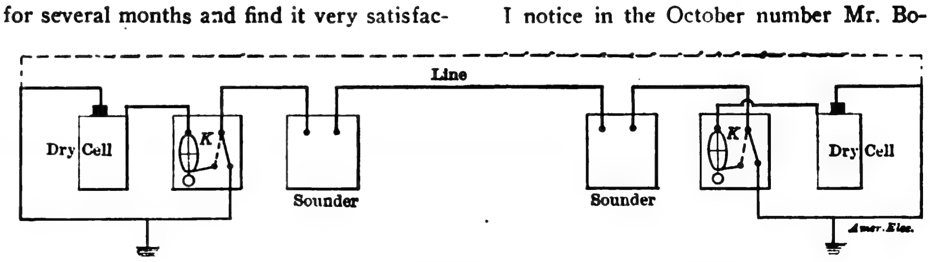


FIG. 9.—TELEGRAPHING WITH OPEN-CIRCUIT BATTERIES.

Fig. 8 herewith shows a method of using dry cells for short-line telegraphy. Only one line wire is used. An ordinary telegraph key may be used, and by insulating the spring switch contact from the post on which it is mounted and connecting it to ground, the two-way switches shown may be dispensed with. The operation of the switch and key are then the same as when operating on a closed-circuit line. In the diagram, S is a sounder, K a key, and P a two-way switch.

Reno, Nev. L. D. STOVER.

I was interested in Mr. Jackson's sketch in the October number, and enclose a sketch, Fig. 9, for telegraphing with open circuit batteries using one line and the ground. The regular switch is removed from the telegraph key and a three-way switch mounted on the same base with the key, using it in the same manner as a regular switch. Similar poles of the battery are connected to ground.

Waxahachie, Texas. W. J. FUSTON.

Continuous Ringing Alarm Bell.

I notice in the October number Mr. Boquet's inquiry about a continuous ringing alarm bell. I would suggest in reply to his inquiry that he fit two swinging hammers on the shaft of his ¾-h.p. motor and fasten the motor close to the bell so that

the hammers can strike it. The weight of the hammers will depend on the starting torque of the motor; but a little experimentation will suffice to ascertain this, care being taken not to choose too heavy a weight as this might under the action of the motor crack the bell. I believe with this arrangement he will be able to awaken the heaviest sleeper in his town. The motor may be started from any convenient place, provided it is a self-starter. Reducing gear might also be introduced if it is advisable to use heavy hammers.

Electric, Mont. J. M. Schmidt.

Mr. Mahaffey's Problem in Lamp Installation.

Enclosed find a solution of Mr. Mahaffey's problem in incandescent lamp wiring published in the October number. The diagram, I think, explains itself, each lamp

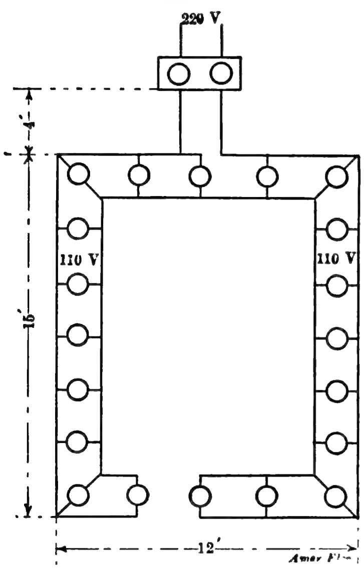


FIG. 2.—MR. BULLARD'S SOLUTION.

receiving 110 volts. The total length of wire from the fuses is approximately 146 feet.

Boonton, N. J. N. E. Weekes.

Enclosed herewith is a solution to Mr. Mahaffey's problem in lamp installation. The potential of the feed wires being 220

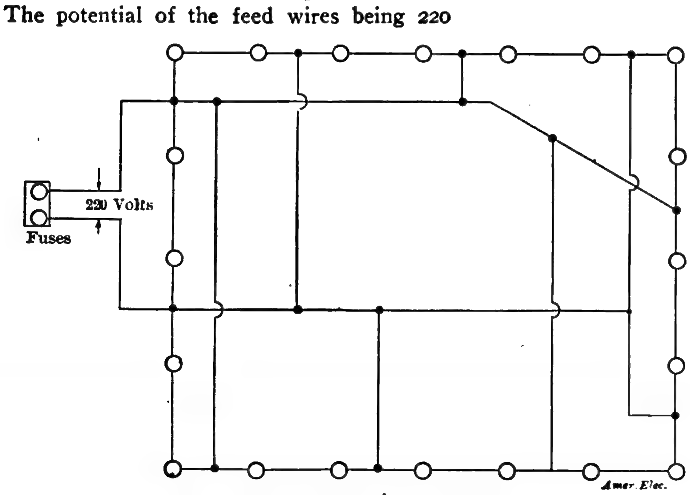


FIG. 1.—MR. WEEKES' SOLUTION.

volts and the potential of the lamps 110 volts, I have employed the three-wire system, which would require only about 107 feet of wire.

Schenectady, N. Y. J. E. Bullard.

Similar solutions were received from J. S. Gibbs of Dallas, Texas, and W. C. Wight, of Portland, Ore.

I send herewith a wiring diagram for Mr. Mahaffey's problem published in the October number. Ten lamps are placed in multiple on one side of the circuit and ten on the other side; the neutrals are then

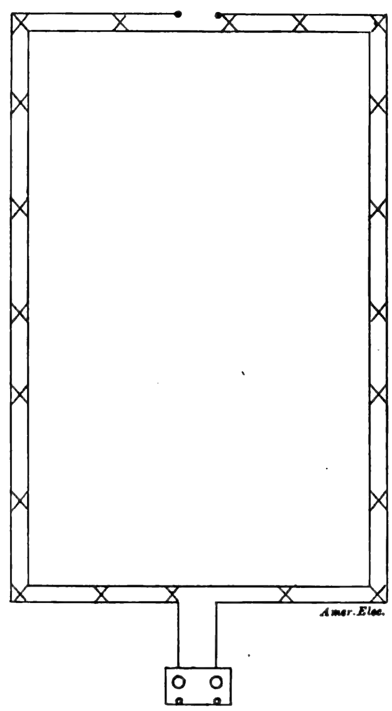


FIG. 3.—MR. MARSHALL'S SOLUTION.

connected together, thus placing the two banks of lamps in series. If one or a number of lamps burn out on one side, the voltage on that side will increase to such an extent as to affect the life of the remaining lamps; but if the lamps were placed two in series across the line a fault in one would throw out the other, or the extinguishing of one would necessarily mean the extinguishing of the other.

San Francisco, Cal. J. J. Marshall.

Mr. Marshall's solution is similar to Mr. Mahaffey's solution of his own problem.

Mr. Mahaffey's problem in lamp connections published last month may be readily solved as indicated in Fig. 4 herewith. Two lamps are placed in series across the 220-volt mains, thereby necessitating a minimum amount of wire.

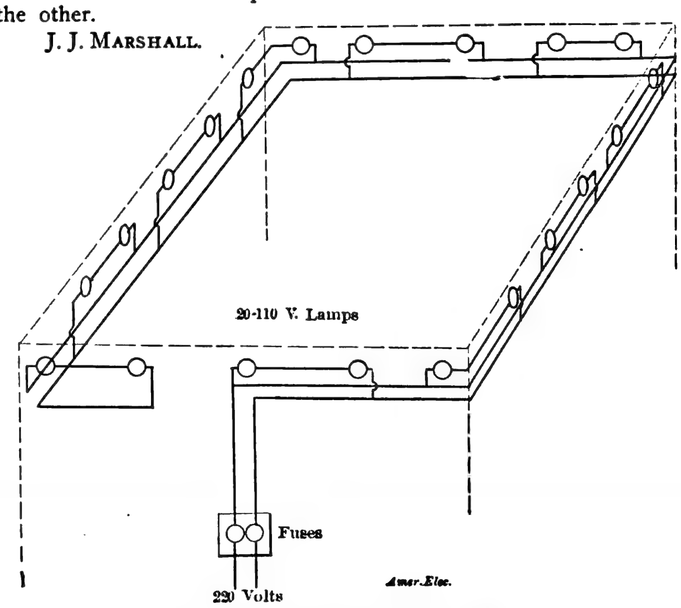


FIG. 4.—MR. ROBINSON'S SOLUTION.

Detroit, Mich. W. P. Robinson.

A similar solution was also received from W. A. McCown, of Ladonia, Texas.

Enclosed herewith is a solution of Mr. Mahaffey's problem in wiring, which was published in the October number. The diagram is so plain and the connections so simple that further comment is unnecessary.

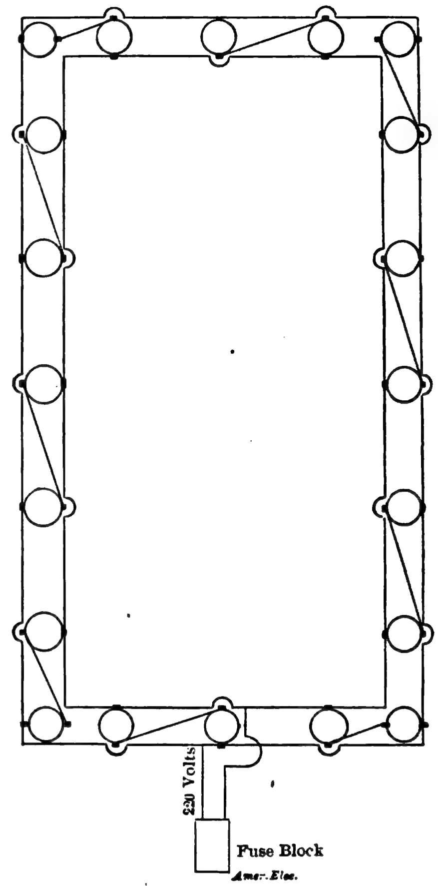


FIG. 5.—SWAFFIELD'S SOLUTION.

Elkhart, Ind. R. Swaffield.

A similar solution was received from H. S. White.

Questions and Answers

Inquiries not accompanied by the name and address of the inquirer, will not receive attention.

How can the current in a three-phase circuit be measured by a single ammeter? R. P. F.

This can only be done if the three phases are balanced. The current would then be equal to that indicated by the ammeter times 1.732.

What substance should I add to feed water in order to guard against scale in the boilers? C. E. W.

This can only be determined by chemical analysis. Unless you are a chemist it would not be wise for you to undertake to doctor the feed water.

When connecting a shunt-wound motor to a railway circuit, should the ground connection be brought directly to the motor, or should it pass to the starting box? W. P. H.

It is better practice to connect the motor to ground, since this affords better protection to the armature of the machine.

Can lead-covered cables be used for transmitting high-tension current? C. M.

Yes; but the use of lead covered cables should be avoided unless absolutely necessary. Wherever possible, high-tension wires should be run in open sight and be rigidly supported upon insulators of good design.

What substance should be used to insulate the secondary wires of a high-potential transformer? In "Electrical Designs" one is told to wind the coils on a form and then tape and bake. What insulation should be used between layers of these coils? S. F.

Fill the transformer casing with paraffine oil.

Why is not mercury more commonly used for switches? (2) What is the best kind of oil for an oil-break switch? A. B.

The reason mercury is not used is because it forms an amalgam with most metals, so that it will leak out of a metallic receptacle. (2) Fusal oil.

How can I protect an iron pipe from the deleterious effect of salt water? We use salt water for condensing purposes, and an iron pipe is used for an intake; but this rusts and is eaten away. T. W.

Iron pipe dipped in liquid asphaltum, rather than coal tar and pitch is said to afford the best protection.

I have some instruments finished in bright brass and wish to know if the brass can be easily oxidized or made black? G. O.

A mixture generally employed for the production of a black or oxidized finish on brass consists of a solution of carbonate of copper in ammonia. The brass is immersed in this solution and allowed to remain until the desired tint is obtained.

Why do alternating-current fan motors take so much more current than direct-current fan motors? H. T.

Small alternating current motors are less efficient than small direct current motors since the former do not operate at unity power factor and require in addition shading coils for starting which are always in circuit and thereby entail a continuous loss.

In transforming three-phase currents, can two transformers be used in place of three? B. B.

Two transformers may be used provided the primary terminals are connected to the three line wires exactly as two incandescent lamps would be connected to the wires of an ordinary three-wire system, and the secondary wiring similarly connected to the three secondary wires.

We have a compound-wound dynamo, and the brushes have to be shifted every time the load varies to any extent, and as the load increases the voltage drops. How can this trouble be remedied? N. C.

The reason the voltage of your machine drops as the load increases is because the series winding is wrongly connected. If you will reverse this your troubles will probably be at an end.

When installing a rotary converter, is it good practice to insulate the frame of the rotary from the ground? F. L. D.

There may be instances where this is desirable; but as a rule, rotary converters are not thus insulated, since by insulating the frame the danger to the attendant is increased, although the strain on the insulation of the windings is thereby decreased.

Can two direct-current motors of the same voltage but of different sizes and speeds be belted to the same shaft, provided the pulleys are of the proper size? B. M. P.

Yes. The size of the pulleys should be calculated, however, on the basis of the actual speeds of the motors under full load. Any discrepancy in the speeds at lighter loads would then only result in dividing the load unequally without harming the motors.

Can I cut out a damaged armature coil in a revolving field three-phase alternator, or should the coil be taken entirely out of the slots? M. T. T.

The damaged coil may be disconnected from the armature circuit and its place bridged over with a piece of wire; it would be better, however, to remove the coil entirely, as any e.m.f. induced in it may damage it further, and this may extend to neighboring coils.

The brushes of a motor chatter and spark to a disagreeable extent. What is the cause of this, and how may it be remedied? J. C. B.

The copper of the commutator evidently wears quicker than the mica used in insulating the bars. The difficulty may be remedied by filing out the mica between the bars with an ordinary three-cornered file until the file touches on both bars, or until the edges of the mica strips are no longer flush with the brush tread of the copper segments.

What is meant by a sneak current, and why should it be avoided? T. M.

A sneak current is a current from some outside source that finds its way into a telephone circuit. It is usually of so small a value that its presence is not readily detected. The danger of sneak currents lies in the fact that if they are allowed to pass through the switchboard or any kind of telephone coil for any length of time, they develop sufficient heat in the coil to ruin the insulation, and in some cases they have been known to start a fire.

How can I remove the burn around the circuit-breaker from a slate switchboard? L. A. B.

The burned portion should first be rubbed with sandpaper until clean. The spot should then be coated with a filler which will not carry current. When this is dry the uneven surfaces should be levelled with good, hard putty. This should then be rubbed down with pumice stone, cleaned and colored. Then apply varnish, and when this is thoroughly dry, polish with butter of antimony and raw oil.

How is it possible to pump water into a boiler by means of its own steam pressure? What prevents the water from running back after the stroke of the feed-pump is finished? W. W.

The steam cylinder of a boiler feed pump is always larger than the water cylinder, and the total steam pressure acting on the steam piston and tending to force the water into the boiler is greater than the total resisting pressure acting on the water plunger. The water is prevented from returning to the pump when the stroke is finished by means of a check valve which is opened by the water forced into the boiler; but is closed by the boiler pressure during the return stroke of a single-acting pump.

Is it economical to install a storage battery to work in conjunction with a power house having moderately fluctuating loads? A. R. M.

The advantages of a storage battery in this case depend to a great extent upon the total capacity of the station. If your plant is small a battery is useful to carry the peak and light loads, and also as a stand-by in case of accident to the generating apparatus. If your station is a large one, the principal use of a storage battery is to take the momentary fluctuations, but if these are small compared with the size of a generating unit, the first cost and maintenance of a battery large enough may be too great to warrant its installation. A battery is, however, useful to render the service immune from interruptions since it can supply sudden demands, and the value of this may entirely outweigh the question of first cost and economy.

I oftentimes have occasion to charge storage batteries from a number of different circuits about the city, and would be obliged if you would give me some ready method of determining the polarity of the circuit. R. S.

You may determine the polarity of a circuit with ordinary litmus paper where the difference of potential is as low as one volt; a red spot appearing at the positive terminal. Paper moistened with a solution of iodic arsenite of potassium yields a black color at the positive terminal. Berghausen's polarity indicator consists of a solution of phenol phthalein and chloride of sodium or sodium sulphate; this gives a red color at the negative terminal which vanishes when the current is off. There are a number of other solutions on the market. Small squares of white blotting paper saturated with a solution of iodine of potassium and allowed to dry form very convenient polarity indicators. When making a test moisten a piece of the paper with water and press it against the terminals of the circuit. The positive terminal will change the color to a pronounced brown while no change of color will be evident at the negative terminal.

MANUFACTURING PLANT OF THE B. F. STURTEVANT COMPANY AT HYDE PARK, MASS.

As the growth and development of the B. F. Sturtevant Company continued in its plant at Jamaica Plain, Mass., the conclusion was gradually reached that the available facilities could never meet the requirements of a thoroughly up-to-date manufacturing establishment.

While negotiations were in progress for the purchase of a new location near Boston the works at Jamaica Plain were visited by a serious fire, April 14, 1901, which destroyed a large amount of machinery and threatened to severely cripple the business. This disaster naturally hastened the final acquirement and development of a site for the new plant. This is now located in the town of Hyde Park, Mass. The new location is only six miles from the old plant and has a frontage of about 1300 feet upon the freight yard of the N. Y., N. H. & H. R. R., at Readville Station. One side of the lot is bounded by a plentiful stream and the adjacent shore is at a level of more than 10 feet below that of the yard and buildings, thus providing sufficient space for dumping waste material for years to come.

The arrangement of the buildings is such as to limit as far as possible internal transportation to straight line movements. A complete industrial railway system of 2 feet gauge connects all departments; spur tracks from the New Haven yards facilitate the movement of raw material and products; traveling cranes, pneumatic, electric and manual hoists and electric elevators are scattered throughout the works and all machinery is motor-driven with the exception of the ventilating fans and air-compressor equipment.

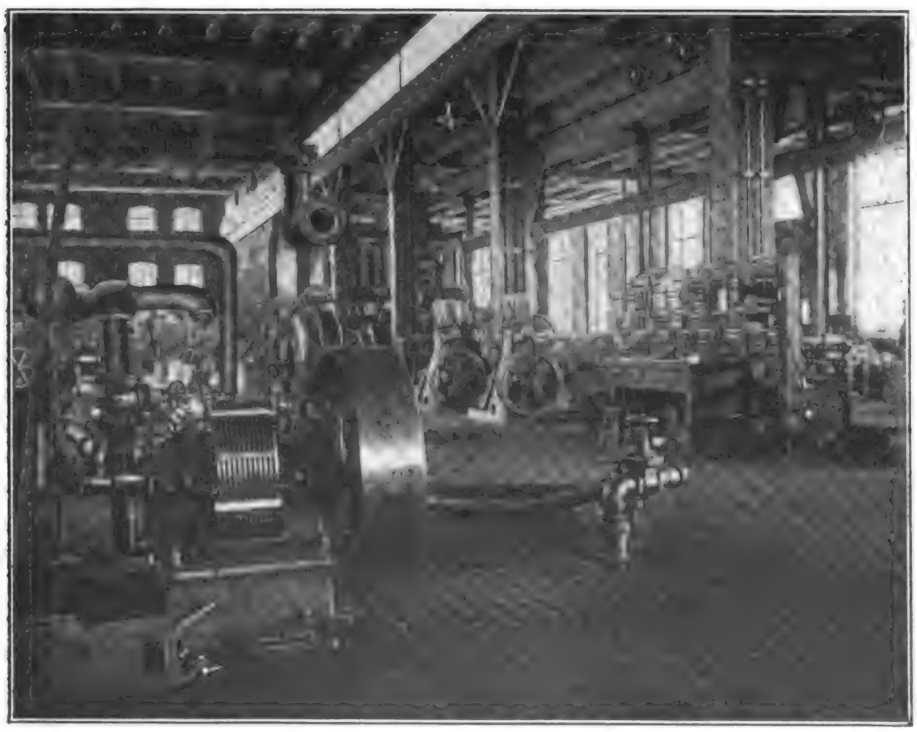


FIG. 1.—CORNER OF TESTING PLATE AND SWITCHBOARD FOR SAME.

The power plant was located about 250 feet north of the shop buildings, so that the latter might be amply extended, with the former still near enough to reduce to a minimum the expense of conveying condensing and other water, transmitting steam, electricity and compressed air. The boilers are of Stirling make, with a total rating of about 1000 horse-power, and the plant naturally contains mechanical draft apparatus and a Sturtevant economizer. The generating sets were built by the company and consist at present of a 100-kw. and a 250-kw. machine. The engines are of the vertical, cross-compound type and are operated condensing. A concrete tunnel 6 feet 6 inches high and 5 feet wide connects the power house with the various shops, and it contains all piping and transmission circuits. It is lighted by incandescent lamps. The power house supplies all the steam used in the different buildings through an 8-inch, 160-pound line which branches to a minimum diameter of 2 inches in the pattern building with 2½ inches in the office building, and a 14-inch pipe carrying 5 pounds pressure to the various heating coils. The high-pressure steam is reduced to 80 pounds for the operation of fan engines, and the latter exhaust into the heating system, which is a typical Sturtevant installation. The testing department uses 160 pounds steam in its work upon compound, direct-connected sets.

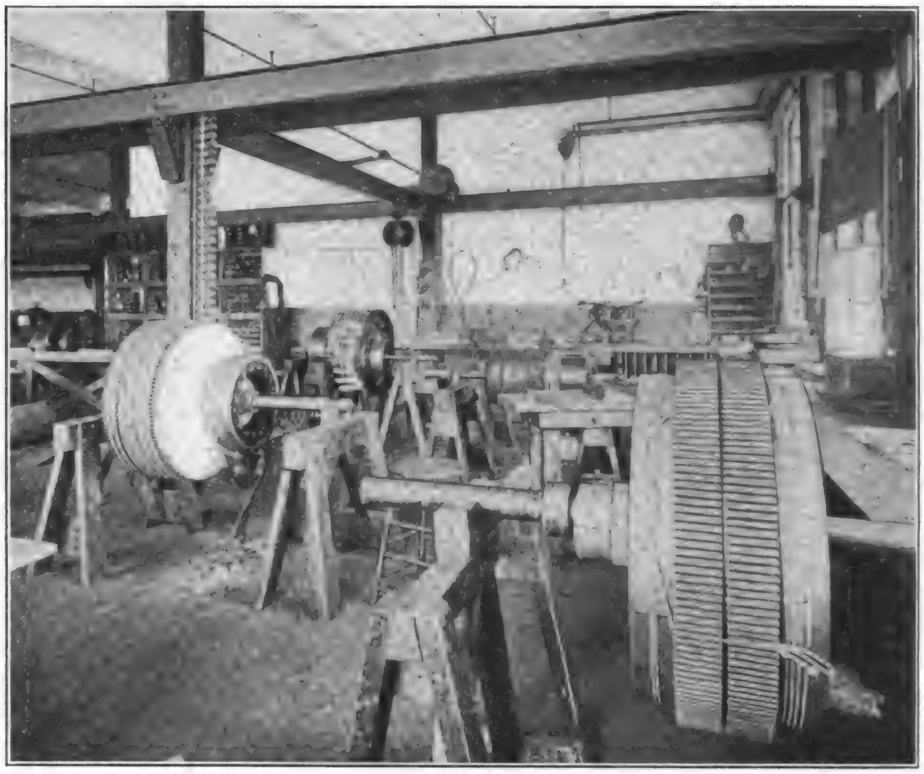


FIG. 2.—ARMATURES BEING WOUND IN ELECTRICAL DEPARTMENT.

All the electrical distribution is carried out upon the two-wire plan at 220 volts direct current for both power and lighting. The largest cable used in the ducts is 1,500,000 c.m. A maximum drop of 2½ per cent was figured between the power house and the load. General illumination is supplied by General Electric 110-volt enclosed arc lamps run two in series, and all special lighting is by 16-c.p., 220-volt incandescent lamps. The air compressor in the power house is a Laidlaw-Dunn-Gordon machine with compound steam and compound air cylinders, distributing air at 100 pounds pressure throughout all the shops. Junctions in the main 6-inch supply pipe provide for the different buildings, which are supplied by 3-inch pipes. Tools are supplied through 1-inch pipes and the air is widely used in drills, hoists, riveting hammers, chisels, snaggers, for blowing out generators, motors and cylinders.

There are about 100 electric motors in the plant, varying in size from ¼ to 40

horse-power, all being of the company's make. Both group and individual driving of machines are in use. The tools are in general arranged to facilitate the direct progress of the work from the receiving ends of the shops toward the finished stores, erecting, testing and shipping departments. Machines, group-driven, are as a rule operated in sets requiring about 20 horse-power, and a motor of this capacity is assigned to all such groups. The machines are as far as possible arranged in duplicate and space is left for additions in supplementary parallel rows. All motors above 10 horse-power are equipped with General Electric circuit-breakers, enclosed fuses being used in smaller sizes. Starting boxes and controlling switches are located either on posts close by the machines, or in the case of some connected motors, upon the machine frames. Practically all the motors used in group driving are hung from the ceilings. The starting boxes are equipped with self-closing doors lined with asbestos. The bench lighting is arranged so as to give each employe as far as possible left shoulder illumination. Incandescent lamps for this work are hung from porcelain rosettes attached to a horizontal wooden strip suspended upon wall brackets. The strip is about 10 feet above the floor and the lamps, with attached downward reflectors, are about 1 foot above the average man's head. At various points in the factory where power is required for testing or other temporary purposes, plug boxes are installed upon certain of the vertical columns within easy reach of the floor. These boxes are fitted with one jack on each side and with fuses or other circuit-breaking devices inside, self-closing doors and asbestos lining.

Several motors are effectively used in the pattern shop and foundry. In the former, the flask shop band, cross-cut and splitting saws, boring drill machine and lathe are all driven by a 10-h.p. motor, while the carpenter shop or pattern-making division proper is equipped with two 10-h.p. motors which operate two band saws, a buzz planer and a double surfacer, five lathes, a drill press, core box machine and wood trimmers. Both these motors are required in ordinary work, one serving as a possible relay in case of accident. In the foundry, a 15 and two 20-ton Whiting electric traveling cranes are in regular use upon the two runways, and the floor between the runways is served by a number of 1½-ton electric traveling hoists with 10-ft. span, built especially for the work by the company. The cupolas are two in number, of Whiting make, 56 in. and 72 in. in diameter. The former is supplied with air by No. 8 Sturtevant pressure blower driven by a 30-h.p. motor, and the latter by a No. 10 blower driven by a 40-h.p. motor. In the brass foundry, blast for the furnaces is supplied by a No. 3 Monogram blower, and the entire machinery, consisting of a sprue cutter, a magnetic separator, a tumbling barrel and emery wheels, is driven by a 5-h.p. motor attached to the wall. A 5-ton three-motor electric Whiting crane serves the principal portion of the floor in the cleaning room. In the core department is a Blake wire straightener, driven by a 5-h.p. motor. All the elevators in the works are electrically driven by Sturtevant motors. The principal traveling cranes are all of Whiting make, with Sturtevant motors.

FIG. 4.—ELECTRIC FANS UNDER TEST IN ELECTRICAL DEPARTMENT.

Armature punchings and commutators are built up in the uppermost floor of the fan and heater shop, adjoining the testing building. The storage of commutators and parts is effected on divided pigeon holes, numbered according to the shop scheme for quick reference. The armature baking room is 40 ft. square, entirely fireproof, and it contains two steam heated baking ovens, fitted with sheet iron doors and discharge ducts. At the other end of the building is the special store room for electrical supplies. The balance of this floor and of the intermediate floor below is de-

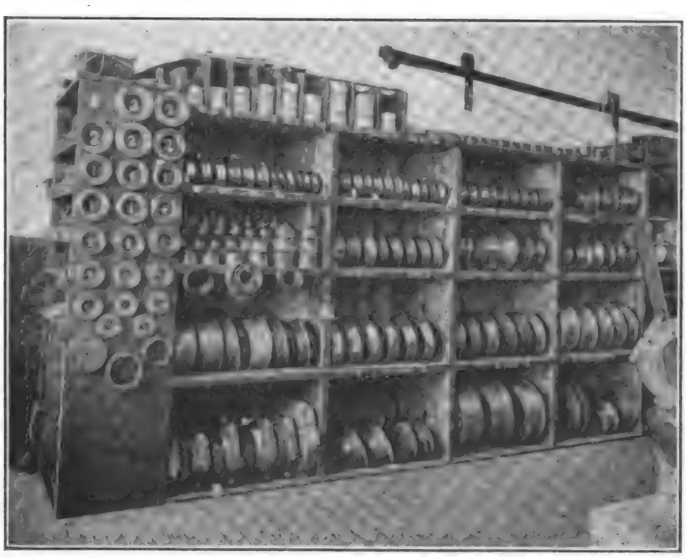


FIG. 3.—COMMUTATOR RACKS IN ELECTRICAL DEPARTMENT.

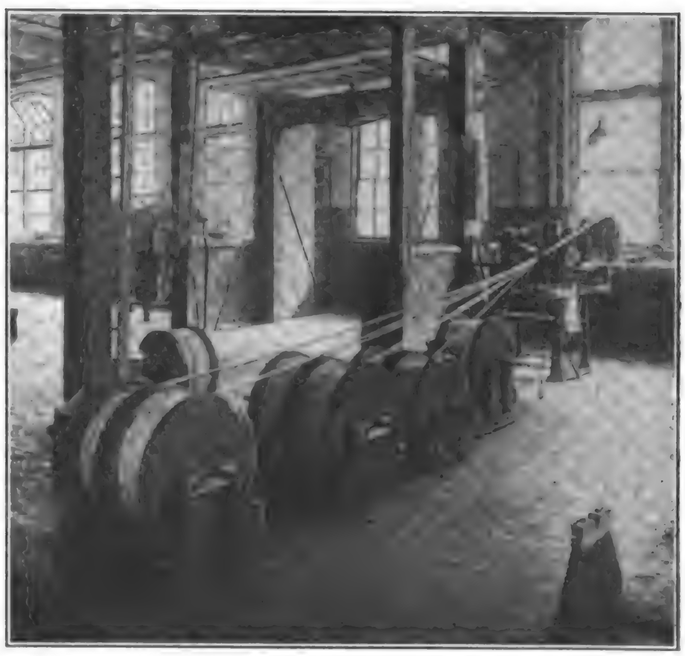


FIG. 5.—WINDING MACHINE IN ELECTRICAL DEPARTMENT.

voted to winding, assembling and testing.

Heavy testing is mostly carried out upon the first floor. Here is a testing plate 30 ft. x 60 ft., completely equipped with steam and electrical connections; engines may be run condensing or non-condensing, and efficiency tests, compounding tests and heat runs conducted. Flexible and rigid pipe sections, portable belted tachometers, steam trap and electrical testing connections, movable racks of lamp banks, scales and water rheostats complete the equipment.

The winding department on the third floor is arranged conveniently with bench scales, reel frames, magnet connections at intervals of 20 ft., lamp banks and armature racks. The latter are group-driven, and the daylight supply is admirable. The testing magnet is mounted on a bracket attached to an upright column and is permanently driven by belting from an overhead line shaft. The special trucks used in handling armatures also deserve mention. Small traveling cranes and hoists are constantly in use on this floor, which is equipped with a floor plate for testing motors and blowers. A complete permanent switchboard forms part of the testing room equipment and all direct-current voltages from 80 to 550 are available for testing, as well as alternating voltages up to 2,500, the latter being used in insulation breakdown tests. On the rear of this board are circular bus-bars, to which flexible cables may be clamped as may be convenient. The variation in voltages is obtained by operating motor-generator sets situated at the left of the switchboard previously mentioned. Portable test tables and lamp banks are available; a water rheostat plant is located on the roof, and instruments are stored in the office, which is being equipped for B-H curve tests upon samples of iron used in the machines. The foundry of the company supplies this material, which runs evenly most of the time, but which needs checking magnetically now and then.

The tests performed upon the equipment vary according to the specifications of the purchaser, but all the generating sets and motors are built to withstand the severe requirements of the U. S. Navy. All apparatus sold to the government is subjected to the exhaustive tests which the departments specify; but even commercial apparatus is put through heat runs, insulation, mechanical balances, frictional and commutating tests at the proper loads.

The architects and engineers for the B. F. Sturtevant Company were Messrs. Lockwood, Greene & Company, of Boston. The construction of the plant, including the design of the entire industrial equipment, the purchase of all building material, the hiring of all labor, was carried out by the Sturtevant company.

NEW WESTINGHOUSE RAILWAY MOTOR.

The Westinghouse Electric & Manufacturing Company has brought out a new line of motors for heavy traction, the smallest motor of the new design being rated at 75 horse-power, and the largest at 200 horse-power. Limitations are naturally placed on the size and construction of a motor by the amount of available space on the truck of the car; therefore, the frame of square cross-section was adopted as utilizing this space most advantageously. All motors in this line have cast-steel frames split at an angle of 45° with the horizontal. The axle bearings are carried by the lower half of the field frame and are divided at an angle of 35° with the perpendicular, so that the weight of the motor is supported almost entirely by the part of the frame extending over the axle rather than by the axle cap bolts. By lifting off the upper half of the field casting the armature may be removed from the frame without taking the motor from the truck; or the motor may be removed from the truck by simply taking off the gear case and axle caps. Three bales, conveniently located, make handling of the motor easy. Bolts with nuts and lock washers hold the two halves of the frame together and the axle caps in proper position. Housings for the armature bearings are circular in form and are turned slightly larger in diameter than their seats in the frames so that when clamped in place, all the advantages of a press fit are obtained. Finished shoulders on the housings prevent any lateral movement and also take the entire end thrust of the armature instead of imposing this severe strain on the clamping bolts. Two bolts through the frame at each end prevent the housing from turning. The armature bearings are made of phosphor-bronze bushings finished all over, with a 3/32-in. lining of babbitt metal. If from neglect the bearing should become so hot as to melt the babbitt the armature would be supported on the brass shell and would not strike the poles. Both oil and waste lubrication are provided. The waste comes in contact with the bearings on the low-pressure side and is supplied with oil from separate pockets from below; in this way it is filtered before reaching the bearing. The amount of oil in the reservoirs may be gauged so that it may be kept at the proper level for economical service. It is stated that with intelligent care these bearings will run 100,000 to 150,000 miles. The axle bearings are similar in construction to those of the commutator, except that split bushings are used. Here also lubrication is by means of oil and waste, the oil being supplied from below. The laminated pole pieces are bolted to the top, bottom and sides of the motor frame, which, being almost square in cross-section, permits the use of flat field coils. These coils are wound of copper strap insulated between turns with treated asbestos ribbon and then carefully taped and given repeated dippings in specially prepared insulating compounds and varnishes which make them moisture-repelling and able to stand internal heat. Brass hangers hold the coils in place independently of the poles. The shaft is forced into the finished armature and keyed thereto and may be removed, should necessity arise, without disturbing the windings or commutator. The armature coils are strap-wound and

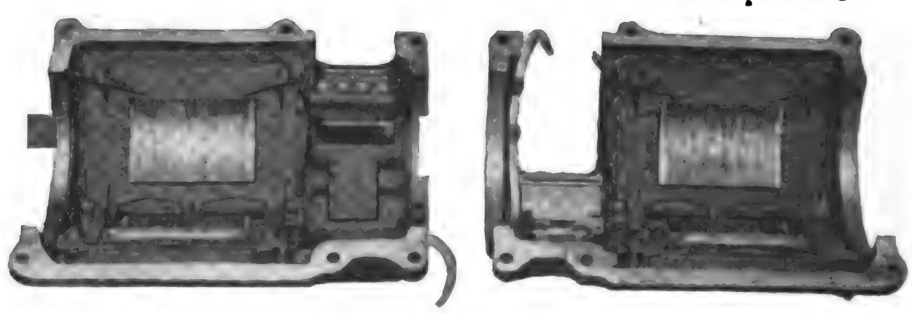


FIG. 2.—INTERIOR VIEWS OF 200-H.P. RAILWAY MOTOR.

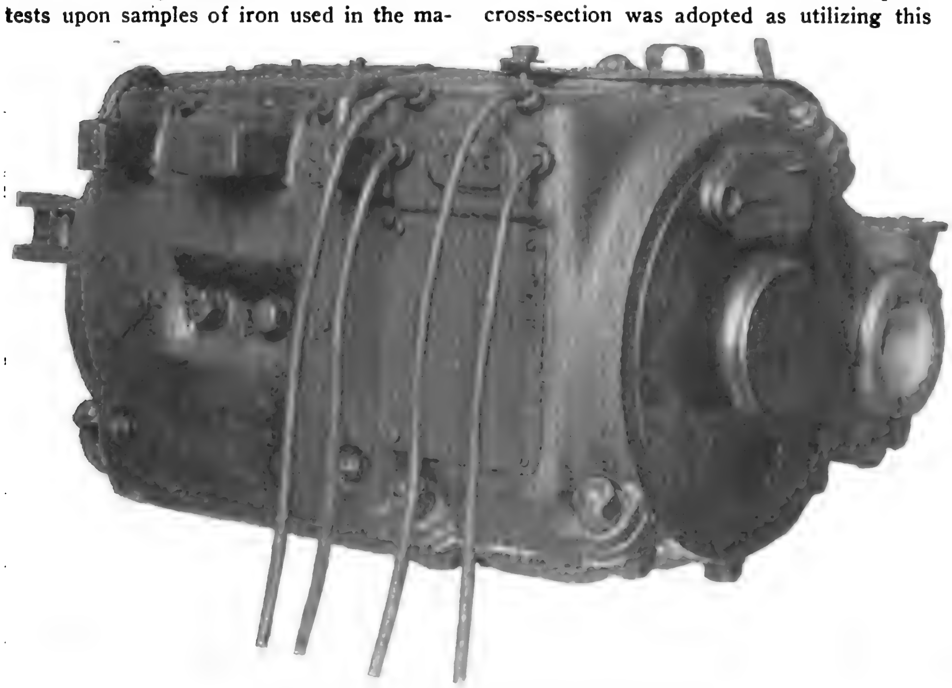


FIG. 1.—EXTERIOR VIEW OF RAILWAY MOTOR.

made in two parts. As the top coils are more liable to injury this design makes it possible to remove the damaged part without disturbing any other part of the winding. The coils are liberally insulated with mica, and sealed and further insulated by dipping in varnishes which are oil-proof and moisture-repelling. On each end the armature slots are made deeper and wider, thereby providing space for mica cells, which greatly reinforce the insulation at these points. As a further protection fibre strips are taped to the upper sides of the top coils. A bell-shaped flange at the pinion end and a cylindrical flange on the commutator end form rigid supports for the windings. Countersunk bands of steel wire on the core hold the coils firmly and securely. Openings through the spider and core allow a free passage of air, which is thrown forcibly against the field coils, thus maintaining a low temperature throughout the motor. The brush holders are of the sliding type with springs of phosphor-bronze held in a harness which definitely fixes the radius of action of the spring tip, and is so constructed as to practically eliminate friction between turns, making it possible to provide a large number of turns, which gives a very uniform pressure upon the brush over a considerable range without requiring adjustment. The tension of the spring may be adjusted without removing the holder from the motor. The brush holder proper is bolted to an insulated guide and may be removed without disturbing the insulation or connections. Leads of flame-proof flexible rubber-covered cable are brought out at the front of the motor over the commutator through insulating bushings. Access to the brushes and brush holders is provided through a large opening in the frame over the commutator which extends well down the side, making inspection easy from the pit. A hole in the rear end bell and an opening under the commutator provide means for inspecting the clearance between the armature and field poles. Pinions used on these motors are machined from steel forgings and held on tapered seats by keys, nuts and lock washers. Gear cases are made of malleable iron and divided along the center line of armature and axle. They are supported only at the ends, which does away with all side strains which are responsible for so many broken gear cases. Nose suspension with safety lugs is used for all motors of this design.

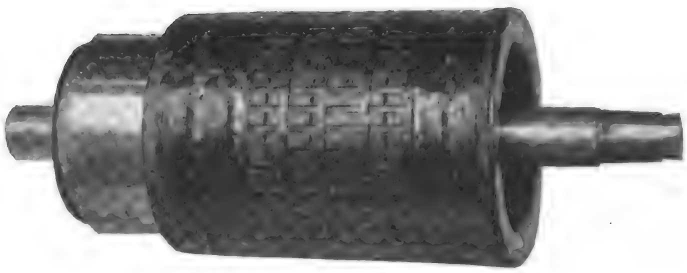


FIG. 3.—ARMATURE OF RAILWAY MOTOR.

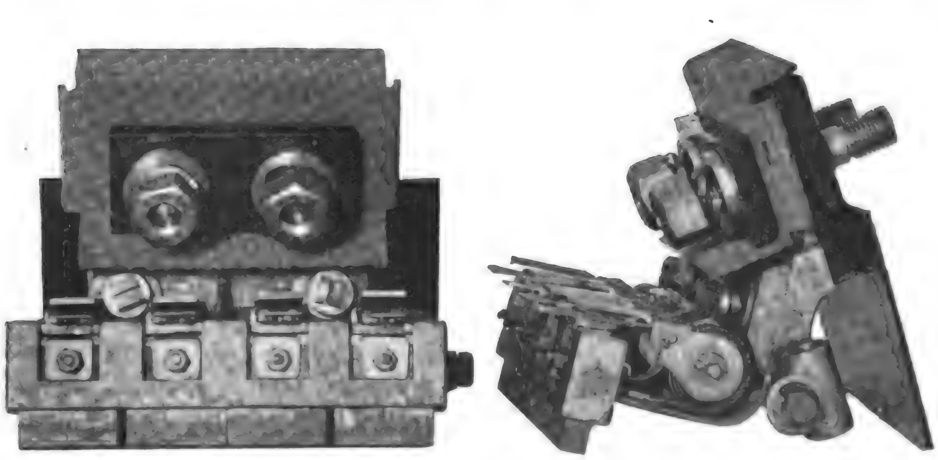


FIG. 4.—FRONT AND SIDE VIEWS OF BRUSH-HOLDER.

SINGLE-PHASE RAILWAY FOR SPOKANE.

A contract has just been closed with the Spokane & Inland Railway Company by the Westinghouse Electric & Manufacturing Company, of Pittsburg, Pa., for the equipment of an electric road, the present terminals of which will be Spokane, Wash., and Moscow, Idaho, 146 miles apart. The roadway is completed from Spokane to Waverly, a distance of 34 miles, and operation will be begun on this as soon as possible. The road is a home enterprise, the stock being held entirely by men living in the district through which the line passes. The directors of the company are J. P. Graves, president; F. A. Blackwell, vice-president; F. Lewis Clark, John Twohy and Alfred Coolidge.

In selecting the equipment for this road, both the direct-current and the single-phase systems were considered, but, after careful comparison the single-phase alternating-current system was adopted. It is claimed that not only did the estimate show a large saving in initial investments and in annual operating expenses in favor of the single-phase system, but a form of heavy traction was made possible which would be practically unfeasible with direct-current equipment. Besides the passenger traffic the company is preparing to do a heavy freight business and also carry mail.

Power for the operation of the road will be purchased from the Washington Water Power Company, which will supply three-phase current at 4000 volts, and 7200 alternations, to a frequency-changing station approximately 1½ miles from the generating station. Seven 750-kw., oil-insulated, water-cooled transformers will step down the voltage from 4000 to 2000 volts, the potential for which the induction motors of the frequency-changing sets are wound. There will be four of these motor-generators or frequency-changers of 1000 kw. capacity each at normal rating. Each consists of a 1000-h.p., three-phase, 2000-volt, 60-cycle induction motor, a 1000-kw., single-phase, 2200-volt, 25-cycle, revolving-field alternator, and a 750-h.p., 550-volt, direct-current generator which is to float on the storage battery acting alternately as a motor and generator. The three machines will be mounted on a single bed plate with seven bearings. Exciting current for the alternators will be supplied by three sets, each consisting of a 75-h.p., three-phase, 2000-volt induction motor and a 50-kw., direct-current generator.

Nine 675-kw., oil-insulated, water-cooled transformers will step up the voltage from 2200 to 45,000 volts, at which pressure it will be transmitted to fifteen static transformer sub-stations, each containing two 375-kw., 45,000-6600-volt, oil-insulated, self-cooling transformers. A 23-panel switchboard, electrically-operated, automatic oil circuit-breakers, and protective apparatus complete the equipment of the frequency-changing station. Low equivalent lightning arresters and choke coil are provided for both the primary and secondary circuits in all sub-stations.

The transmission lines will consist of two No. 2 copper wires and the trolley will be of the standard catenary construction, using a No. 000 wire and carrying current at 6600 volts.

Each passenger car will be equipped with four 100-h.p. motors, capable of maintaining a schedule speed of 35 to 40 miles an hour. In the freight service four 150-h.p. motors will be used on each car. For the heavy freight service double locomotives weighing approximately 70 to 80 tons will be used, each consisting of two parts and each part a complete 35 to 40-ton locomotive. Two or more of these locomotives may be coupled together and operated from the front cab as a single unit. The motor cars and locomotives will all be operated by multiple unit control. The motors will operate under three different conditions: 6600 volts alternating current in the interurban districts, 700 volts alternating current in the smaller towns and 575 direct current in the city of Spokane.

New Apparatus and Appliances

A NEW RECORDING WATT-HOUR METER.

The General Electric Company has recently placed on the market a new type of recording watt-hour meter identical in principle with the earlier forms of Thomson recording watt-hour meters, but differing widely in structural details. This new meter is known as the Thomson recording watt-hour meter, Type C. In general the meter has been made simpler and more compact. The first change in construction to be noted is the method of support. The upper lug is key-holed, and the lower right-hand one slotted. This permits rapid and accurate leveling as the screw can be inserted and the meter hung thereon approximately level. The final adjustments can then be made accurately. The cover is fastened with studs and wing nuts and may be moved directly toward the front, permitting the installation of a large number of meters where space is limited. The sealing wire is passed through the wing nuts and their respective studs necessitating the use of but one wire, and prevents tampering without detection. A felt-lined groove surrounds the edge of the cover and the leading-in holes for the wires are covered with the same material, excluding both dust and insects. In the meter proper a number of improvements have been made. The register is of the four-pointer type with large, clear dials registering directly in kilowatt-hours in all sizes up to 30 kilowatts. Except in the larger

FIG. 1.—RECORDING WATT-HOUR METER.

sizes no dial constant is necessary. Where a dial constant is required a decimal constant has been chosen so that the actual energy unit remains the same, and the correct reading is easily obtained by adding ciphers to the dial reading as the constant requires. The lower bearing is made of sapphire, or in capacities above 50 kilowatts, of diamond. The shaft is tipped with a brass pivot fitted with a very finely polished steel point which, with the jewel cup, forms an ideal bearing surface. The armature shaft is tubular. On the upper end of the shaft and very carefully insulated from it, is the commutator. This is but one-tenth of an inch in diameter, and with the gravity-controlled brushes,

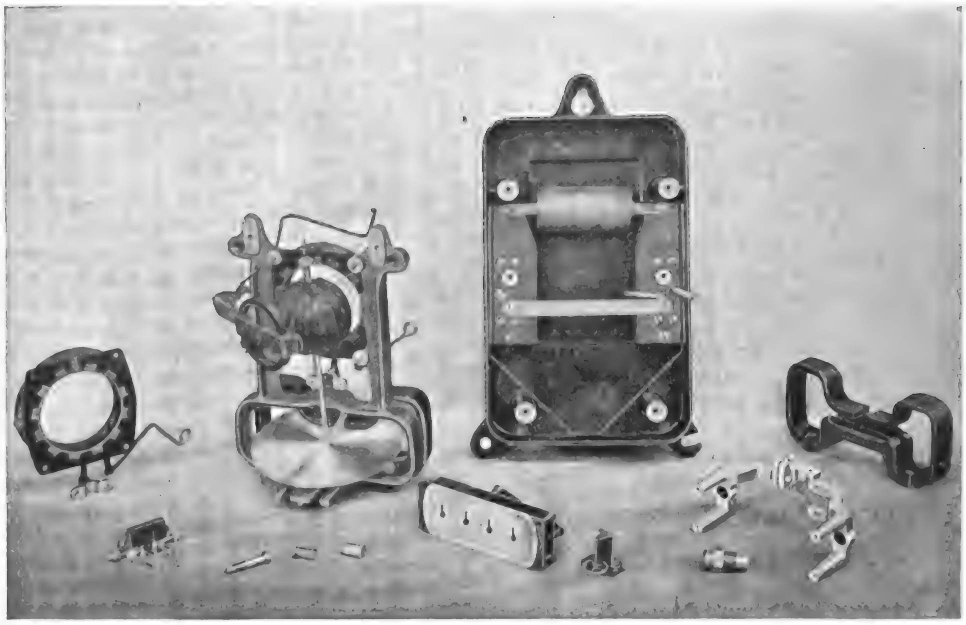


FIG. 2.—PARTS OF RECORDING WATT-HOUR METER.

reduces the friction at this point to the minimum. For protection during shipment and any subsequent transportation the Type C meter is provided with a clamping device which holds the moving element securely in position. This consists of a brass cap which is normally drawn down and held by the jewel screw against the force of the lifting spring. When drawn down the moving element is free to rotate, but when the jewel screw is backed out the cap is released and the spring causes it to lift the moving element from the jewel and hold it firmly. The entire mechanism is assembled upon a skeleton casting which in turn is fastened within the meter casing. By removing four screws and disconnecting the windings from the terminals the mechanism may be removed for inspection and repair. The plane of the field coils is parallel to the back of the meter, hence by the removal of the front series coil and the register, and the loosening of the shunt field coil, the moving element may be taken out. This does not necessitate the removing of the magnets and therefore full-load calibration is unaffected. An automatic link between the worm wheel and the register permits removal and replacement of the latter without in any way affecting the proper mesh of gear and worm. The four magnets are permanently fastened together in sets of two and each set may be removed from its supporting shelf by the loosening of two screws. The armature is spherical and revolves within circular field coils. It is wound from very fine wire upon a paper shell and the field windings are of copper ribbon. The damping magnets are subjected to a rigid process of magnetization and ageing to insure absolute permanence. The peculiar design of the field coils and armature of the Type C meter gives, it is claimed, the greatest possible torque combined with minimum losses and weight of moving element. Although designed primarily for use upon direct-current circuits, the Type C Thomson recording watt-hour meter may be used on alternating-current circuits regardless of frequency or wave form, and if properly lagged upon inductive circuits without recalibration or adjustment. Having no iron in its construction, the Type C meter is not subject to hysteresis action. The meter is manufactured in capacities ranging from 5 to 600 amperes, inclusive, two-wire; and 5 to 300 amperes, inclusive, three-wire; and for potentials from 100 to 600 volts.

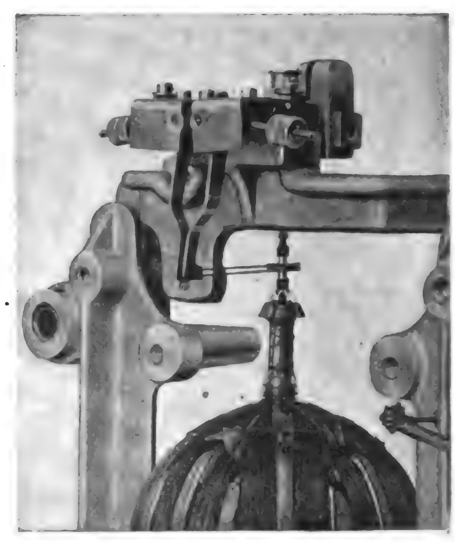


FIG. 3.—INTERIOR OF RECORDING WATT-HOUR METER, SHOWING SMALL COMMUTATOR AND GRAVITY BRUSHES.

AUTOMATIC BELT-TIGHTENING IDLER.

A newly designed automatic belt-tightening attachment for the standard Crocker-Wheeler Form L motor is shown in Fig. 4. It may be used wherever the limited center distances between pulleys require an

increased belt contact on the pulley surfaces. This device is designed so that it may be attached by the customer at any time to any L motor having a rear-end shield. Its principal parts are the idler pulley, arm and block, spring-stud and block and the adjustable spring and hook

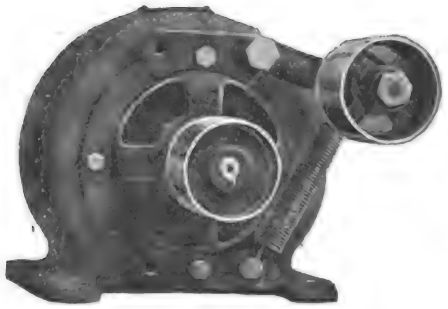


FIG. 4.—BELT-TIGHTENING IDLER.

for connecting them. The idler pulley and arm are pivoted on a stud which may be screwed into either one of two tapped holes in the block. The block itself may be attached to the motor in any one of four positions by a special screw replacing any one of the four machine screws holding the rear shield to the motor frame. Eight locations are thus afforded for the pivot of the idler arm.

IMPROVED RENEWABLE SEAT AND DISC GLOBE AND ANGLE VALVES.

Crane Co., Chicago, has brought out a complete line of improved renewable seat and disc globe and angle valves, some of which are illustrated by Figs. 5 to 9 herewith. These valves are suitable for working pressures up to 250 pounds and are tested to 700 pounds pressure per square inch.

As the accompanying cuts will show, they embody several new and valuable features in their construction. The renewable parts are made of hard and superior composition, and are suitable for hard work, where extreme pressure is used and where the wear and tear on the valve is most severe. By unscrewing the nut on the bottom of valve all parts are accessible and removable from the top, thus making is convenient to substitute a new seat or new disc when required, or to replace any worn part. The construction of the valves is

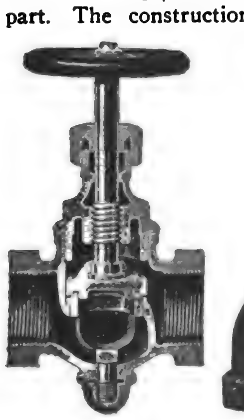


FIG. 5.

FIG. 6.

such that they may be packed when open without steam escaping. The Crane patent renewable seats and wedge straightway valves are made with copper seats and hard metal wedge; they are suitable for working pressures up to 250 pounds and are tested to 800 pounds pressure per square inch. The ready method of inserting these renewable parts and the wide range in the use of these valves on all kinds of severe

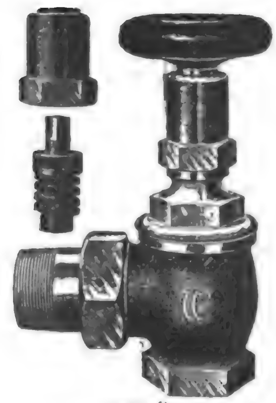


FIG. 8.

service will recommend them to all users. Soft metal rings or seats will be furnished for water or air, when so specified. The Crane "self-packing" globe and angle and radiator valves are made with Jenkins disc and non-rising stem and satisfactorily sup-

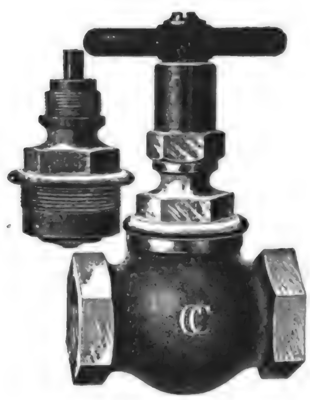


FIG. 9.

ply a demand for valves embodying this very desirable self-packing feature. All users of radiator valves know that leaky stuffing boxes are a source of a great deal of annoyance, caused by the escape of steam and water. In the Crane self-packing valve, a piece of vulcanized rubber is introduced between two metallic parts, which makes a perfect seat. The threads on the bonnet of

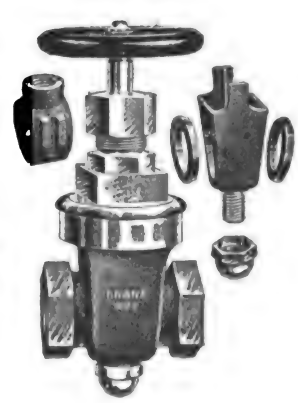


FIG. 7.

these valves are the same size as those in the Jenkins disc valves, made by Crane Co., so that the old style trimmings may be replaced with this new self-packing device, without removing the valve.

WEATHER-PROOF SOCKET PLUG.

The socket plug shown in the accompanying illustration has been designed as a substitute for an incandescent lamp in places where light is not needed throughout certain portions of the year, as in parks, summer resorts, and for sign work. Under

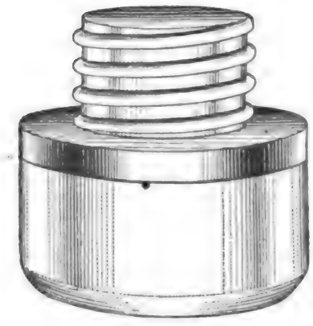


FIG. 10.—WEATHER-PROOF SOCKET PLUG.

ordinary circumstances when the lamps are removed, the sockets, which are left exposed to the elements, become badly corroded and cracked. The breakage resulting from this cause frequently amounts to a very large proportion of the total installation of sockets and receptacles, and the cost of new ones, together with the price of labor necessary to replace them, forms a considerable item of expense. The socket plug illustrated is thoroughly weather-proof. A soft rubber gasket is interposed between the plug and socket, thus making a watertight joint. These plugs are manufactured by the Weather-Proof Socket Plug Company, of Philadelphia, Pa.

KNOWLES EXPRESS PUMP.

The International Steam Pump Company, New York, has bought out a very compact high-speed pumping outfit, known as the Knowles "express" pump. Fig. 11 herewith illustrates one of these pumps, which was installed in the celebrated Comstock mine. The pump is direct driven by an electric motor, the armature of the lat-

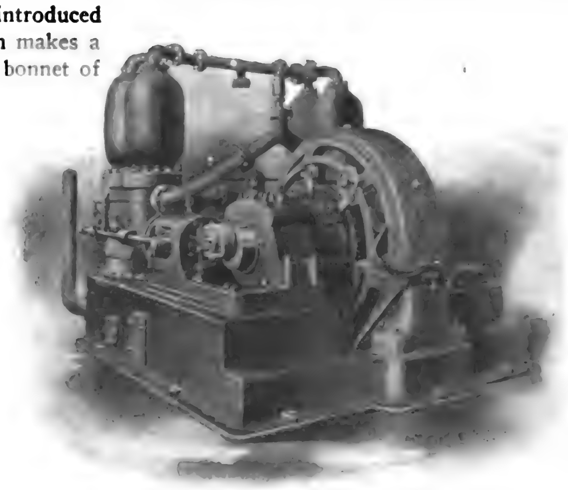


FIG. 11.—KNOWLES EXPRESS PUMP.

ter being mounted upon the main crank shaft without intermediate gears or belting, resulting in a mechanical efficiency, it is stated, of over 93 per cent.

High-speed pumps are usually construct-

ed with mechanically operated valves; some designers advocate mechanically closing both inlet and outlet valves, while others favor mechanical opening. The valves of this pump are of the simple automatically-operated type, the complication of valve-operating gear being avoided successfully. The pump is of the duplex double-acting, outside-packed-plunger type, having cranks at right angles, and the motor armature mounted upon the main shaft,

FIG. 12.—MICANITE CANOPY INSULATOR.

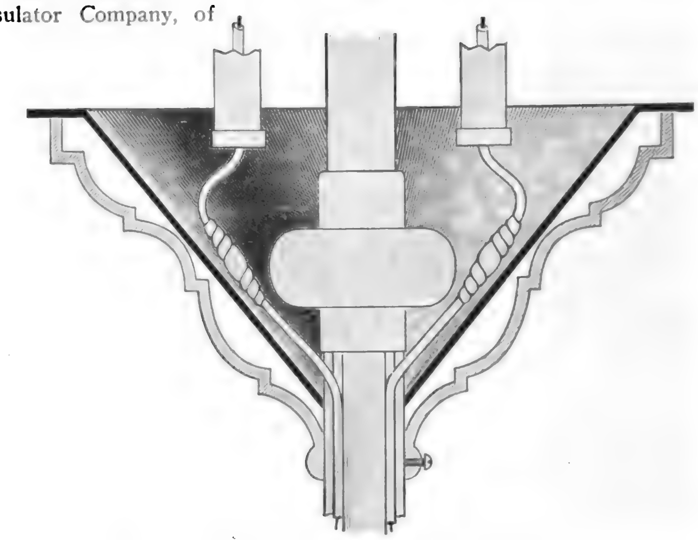


FIG. 13.—MICANITE INSULATOR IN PLACE IN FIXTURE.

as already mentioned. The entire machine is self-contained, mounted upon a rigid box-girder frame and occupies a relatively small space. In a very carefully conducted test, the pump is said to have proved a success in every way, surpassing the expectations of the builders and the purchasers. The operation under all conditions

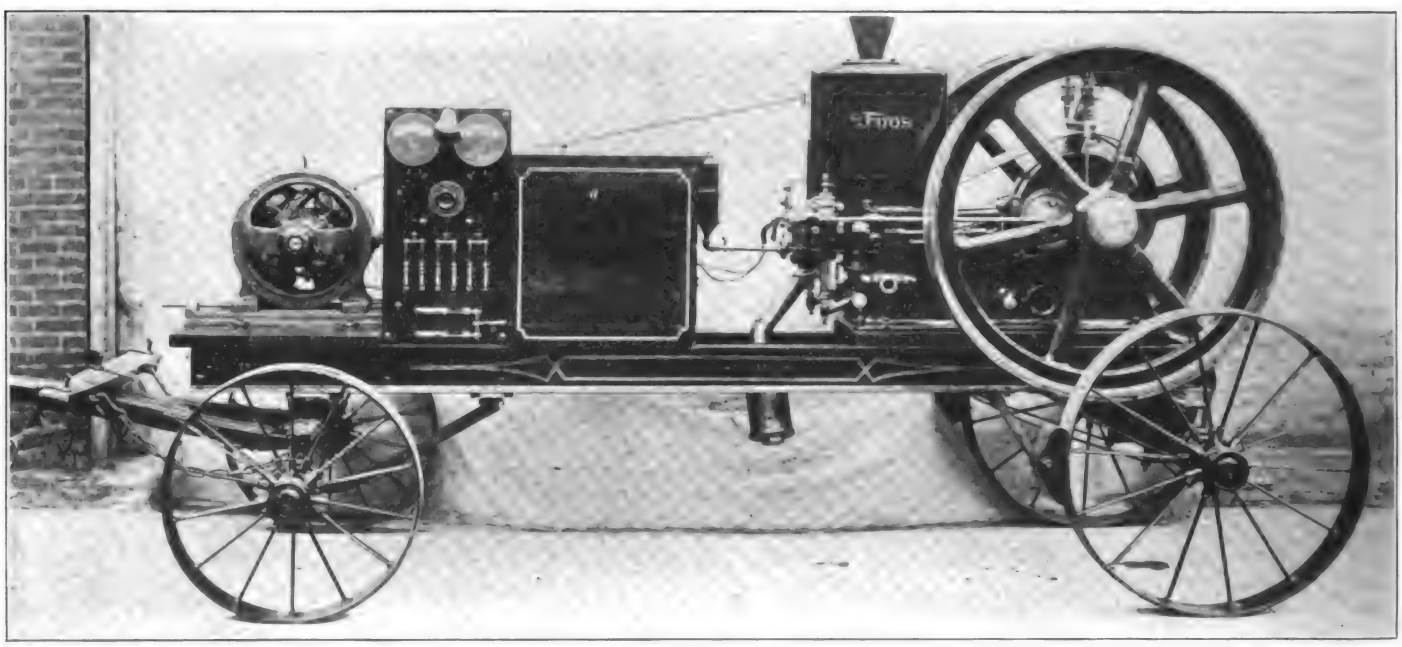


FIG. 14.—PORTABLE GASOLINE-DRIVEN ELECTRIC OUTFIT.

was practically noiseless, and was unaccompanied by the slightest shock or heating. The accompanying illustration represents a pump having plungers 3½ inches in diameter and a stroke of 5½ inches, the capacity being 250 gallons per minute against a head of 1000 feet. The full capacity and pressure for which the pump was built were attained at a speed of about 300 revolutions per minute. Pumps of this type are built in capacities of from 200 to 4000 gallons per minute, and for heads from 100 to 2000 feet.

MICANITE CANOPY INSULATOR.

As a means of eliminating the danger from fires due to defective insulation in electric light fixtures at the point where the wires project through the floor or wall and make connection with the wires of the electroliers, the Mica Insulator Company, of New York, has placed upon the market the "Young" canopy insulator shown in Figs. 12 and 13. The insulator is made of the well-known material "micanite," built up from large laminations of mica and moulded with both flange and taper into one solid whole. As seen from Fig. 13, the flange gives protection to the brass canopy from the surface to the ceiling or wall, thereby removing any possibility of a short-circuit between the two conducting wires, between either of the conducting wires and the canopy, or between the wires through the canopy to the ceiling. The insulator is claimed to be absolutely fireproof and the manufacturer says it has been approved by the National Board of Fire Underwriters.

PORTABLE FOOS GASOLINE ENGINE.

The accompanying illustration shows a portable electric outfit which is built by the Foos Gas Engine Company, of Springfield, Ohio, in various sizes for all purposes to which portable electric outfits are applicable. The outfit shown was supplied to a St. Louis concern for operating Cooper Hewitt vapor lamps for a portable photographic outfit. This, of course, is but one of many uses to which the output may be put, it being especially applicable during the winter season for thawing frozen water pipes by electricity. The engine is of the regular Foos type, having the well-known wipe spark igniter originated by this company, vertical positively driven valves, etc. The counterbalancing is accomplished by securing disks to the arms of the crank, leaving the wheels themselves in balance instead of casting weights on them. The result of this is shown very effectively by the steadiness of the portable outfits. The connections are all flexible and while the engine is free to move in all directions, its motion when under full speed is said to be practically unnoticeable. The accessibility of all the parts is one of the company's strong claims for the engine. The dynamo is of the Westinghouse make, as are also the switchboard, lamps, etc. The outfit shown is driven by a 7-h.p. engine.

INCANDESCENT CONCENTRIC DIFFUSER.

The incandescent concentric diffuser recently designed by the General Electric Company, and illustrated herewith, will doubtless prove of interest to those who have in the past been bothered by the problem of ade-

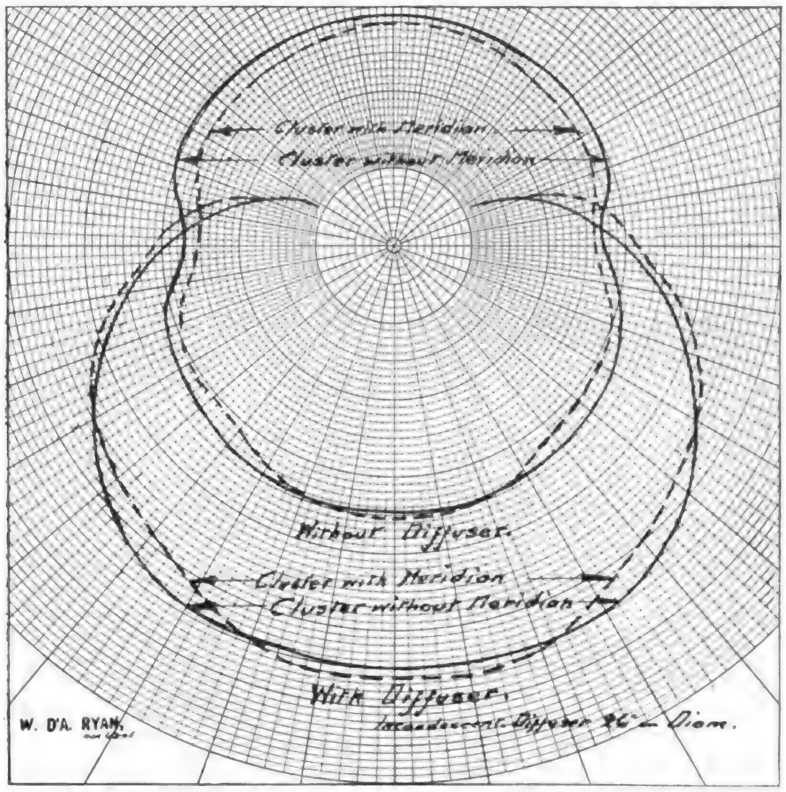


FIG. 15.—CHART SHOWING LIGHT DISTRIBUTION.

quate illumination under mezzanine floors, in basements, and similar places, where low studding eliminates the arc lamp, and large area the separate incandescent lamp. The diffuser is 26 inches in diameter, and is made of steel, coated with high-grade Aus-

FIG. 16.—CONCENTRIC DIFFUSER.

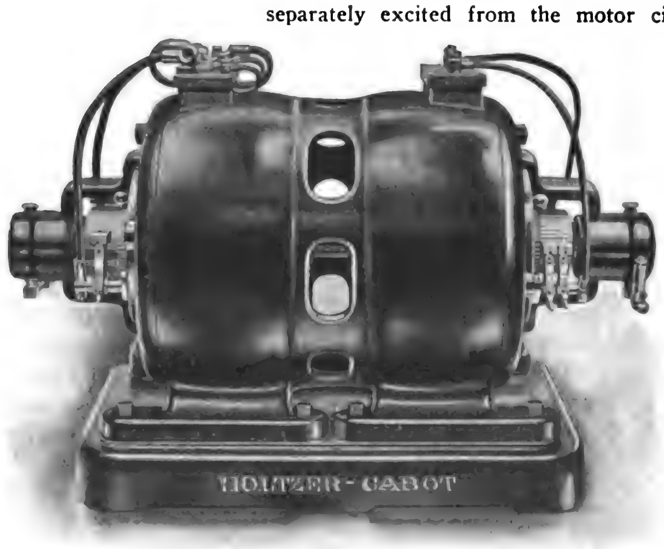


FIG. 17.—HOLTZER-CABOT MOTOR-GENERATOR.

trian air-dried enamel, which does not turn yellow, but it is claimed becomes whiter with age. The black deposit which usually accumulates on the ceiling above the lamp is received by the diffuser, from which it can be readily washed off, so the diffuser protects the ceiling in addition to giving an excellent distribution of light. The diffuser can be installed near the ceiling or on any extension rod, and any standard make of cluster with four-inch base can be used. The best effects have been obtained with one 25 or 50 c.p. Meridian lamp in the lower socket, and 3, 4, or 5 standard frosted 8, 16, or 32 c.p. incandescent lamps set radially, as shown in the illustration. From the chart it will be seen that the lower hemispherical candle power has been increased about 40 per cent and that the general distribution of downward light has been greatly improved. The radial lines shown in the chart correspond to angles of 10° in elevation, being marked in degrees of arc above and below the horizontal. The distance along these lines from the centre to a point on the curve represents the intensity of candle power in that direction. For instance, referring to the solid line curves, at 60° below the horizontal the cluster alone gives 85 candle power. This may be read either at the right or left hand side of the sheet. When the diffuser is used this is increased to 136 candle power, showing a gain of 60 per cent in this particular direction. While it is not advantageous to have all the light concentrated directly beneath the lamp, it is obvious that the most useful light is that thrown below the horizontal and that the light thrown above the horizontal cannot be utilized except as it is reflected downward from the ceiling.

HOLTZER-CABOT MOTOR-GENERATORS.

With the increase in use of the storage battery for launches, automobiles and private lighting plants has come the demand for a compact and efficient form of charging motor-generator. The advantages of the motor-generator over the dynamotor for work of this class are well known. In the first place, the primary and secondary circuits of the motor-generator may be much more effectively insulated from each other than can the windings of the dynamotor. Furthermore, the secondary voltage of the dynamotor form of machine cannot be regulated except by means of a line rheostat in the secondary circuit or a speed controller in the motor circuit using resistance in series with the armature, both these methods requiring expensive rheostats and producing a very uneconomical conversion. The motor-generator form of machine is more flexible in its adaptation to the engineering conditions. The voltage of the secondary may be regulated by the field rheostat and if the fields of the generator are separately excited from the motor circuit the voltage of the generator may vary from zero to the full potential of the machine, the current output and stability of voltage being retained throughout the entire range. The machines here illustrated have two bearings,

the two intermediate bearings being eliminated. The motor and generator cores are mounted on a common shaft, which is continuous. The speeds are low and the shafts quite heavy, so there is no tendency of the shafts to spring. The output of the machines ranges from 1/4 to 4 1/4 kilowatts. The machines may be wound for any direct-current circuit and the secondary wound to give any voltage from 20 to 500. The manufacturers are also prepared to supply machines of the same range and outputs of the two-bearing construction, but of the open type. There is no particular preference in favor of either type, although possibly the open type is a little more accessible. While these sets are intended primarily for charging batteries they have been found useful in other lines of work, particularly in telegraphic work for operating main and local circuits. These motor-generators are manufactured by the Holtzer-Cabot Electric Company, Boston, Mass.

ELECTROLIER KEY SOCKET AND COMBINED SOCKET AND SHADE-HOLDER.

The electrolier key socket, shown herewith, designed a short time ago by the engineers of the General Electric Company, Schenectady, N. Y., is very compact, and

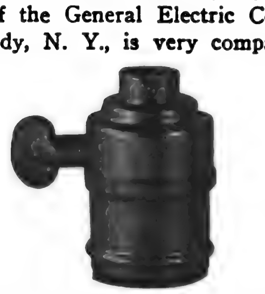


FIG. 18.—ELECTROLIER KEY SOCKET.

has a well-finished appearance, harmonizing with decorated electroliers. A metal key, thoroughly insulated from all live parts, accompanies the outfit. This key is removable, and an extension key may be used in its place. The combined socket and shade-holder shown in Fig. 19 is said to have met with the approval of many users. The

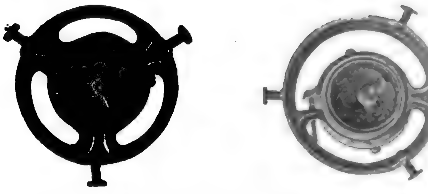


FIG. 19.—COMBINED SOCKET AND SHADE-HOLDER.

shade-holder in the new device is permanently attached to the socket shell in such a way that it cannot slide or turn. This, together with the fact that three points of support are afforded the shade, eliminates any sagging.

AMERICAN ELECTRICAL SALESMEN'S ASSOCIATION

During the convention of the Illinois State Electric Association at Peoria the salesmen present organized a new electrical society under the name of the American Electrical Salesmen's Association. Although nearly every other branch of the electrical industry has one or more organizations for mutual benefit, the salesmen, while frequently meeting at associations and elsewhere, have had none. The new association is designed to fill this vacancy and to be national in scope. Its motto is "Fraternalism," and the object is the uplifting of the standard of salesmanship and the general advancement of the electrical interests. The idea is that the members may strive mightily, but fairly, for business and still eat and drink as friends.

All salesmen selling electrical apparatus of whatever nature are eligible to membership and are invited to join. "Shop talk" is strictly barred at all meetings by the by-laws which have been adopted; the paramount idea is social intercourse and mutual improvement. There are to be no dues. Each new member is to pay a dollar for an emblem. Minor expenses, as printing and postage, will be paid from the profits on these emblems. A man once a member is always a member unless he resigns or changes his vocation. One general meeting is to be held each year; the first one will be held in Chicago next January during the Electrical Exposition. But at these meetings there will be no exhibit or advertising of any manufacturer's goods. This provision is, of course, essential.

It is hoped, by making the organization as simple as possible and omitting all obligations, that the association will help its members to become better salesmen and better citizens, loyal and zealous in their employers' interests and yet manly and honorable in their treatment of fellow members.

Following are the names of the officers of the new association: President, Vincent Gray, St. Louis. Vice-presidents—H. N. Remington, Peoria; A. A. Morton, Chicago; J. T. McNair, Yonkers, N. Y.; C. R. Wood, Moline, Ill.; A. L. Pond, Chicago. Secretary, George H. Erich, 218 North Court Street, Rockford, Ill.

NEW BOOK.

MAXWELL'S THEORY AND WIRELESS TELEGRAPHY. Part I, Maxwell's Theory and Hertzian Oscillations, by H. Poincaré, translated by Frederick K. Vreeland. Part II, the Principles of Wireless Telegraphy, by Frederick K. Vreeland. New York: McGraw Publishing Company, 1904. Cloth; 255 + xi pages, 8 1/4 in. by 5 3/4 in.; 145 diagrams. Price, $2.00.

The name of Poincaré is sufficient guarantee of the first part of the book, without any comments by the reviewer. The author starts with the proposition that it is a fruitless task to attempt a complete mechanical explanation of electrical phenomena in all their details; but, on the other hand, it is important to show that these phenomena obey the general laws of mechanics. He then proceeds to show how Maxwell modified the then existing electrodynamic theories, so that the principles of optics could be derived therefrom. In this exposition, the author uses mechanical analogies freely, but only to illustrate general principles; for example, the flow of conduction and displacement currents, oscillatory discharges, etc., as distinguished from the elaboration of hypothetical mechanisms for explaining the ultimate nature of the phenomena. This part of the book, which occupies nearly one-half of the volume, is written in a clear and accurate style, and is made as simple and elementary as possible. It forms a good theoretical foundation for the study of wireless telegraphy, as is intended.

The second part of the book begins with general principles, then describes some of the early experiments, then some of the later apparatus, ending with selective signaling systems. In this part the principles developed in the first part are applied to practical apparatus. On the whole the book treats the subject in a very satisfactory manner.

FOREIGN TRADE POSSIBILITIES.

(By Our Special Correspondent.)

There is every indication that the requirements for equipment in electrical lines in Mexico during the next few years, with regard to street traction, light and power plants, will be of a character well worth the careful attention of American machinery and supply houses. Now that the Mexican municipal authorities are realizing the possibilities which electricity offers, transformation of mule car lines to electric power will proceed on a scale hitherto unprecedented. Work along these lines has already been commenced and is being pushed vigorously.

It is well known that throughout Mexico, in the mining as well as the agricultural districts, the old-time mule car system has long prevailed. In a comparatively very few towns these have been supplanted by electric power, Mexico City itself, the capital setting the example, although there are yet in the Mexican metropolis many miles of mule car lines in regular operation. But as might have been expected, the results have been so satisfactory where electricity has been introduced in street car traction that every municipality in the Mexican republic where the mule car system prevails, and especially where water power is available, is clamoring for the introduction of the new and modern system of electric motive power. Nor will the Mexican people be satisfied until this transformation is accomplished, however great the undertaking.

La Electrica Company, of Guadalajara, which has obtained the concession for electric street traction in that city, will expend $3,500,000 in purchasing steel rails, copper wire, cars and equipment for a hydro-electric plant.

The Compania Electrica de Aguascalientes will also expend a large sum in the purchase of copper wire, power equipment and cars.

The municipalities of Monterey, Colima, San Luis Potosi, Morelia, Toluca, Oaxaca and Puebla have each formulated plans for raising the necessary capital to abolish the mule car and install in its stead the electric car.

The announcement is made by a Mexican Government official that a concession has been granted to Gustave A. Lilliendahl to utilize 9000 liters of water per second from the San Juan River, in the municipality of Santiago, State of Nuevo Leon. The object of the concessionaire is to produce electric power for local use or for transmission to any points which he may desire. Surveys must commence within six months, construction of the works to begin within two years and to be completed within seven years.

Albert Stein, representing the Jaqui Copper Company, of Sonora, has applied for a concession to utilize a maximum of 340,000 liters of water per minute from the Zaqui River, for the purpose of producing power by electricity.

Luis Gomez Daza, Zacatlan, Puebla, has made application for the purpose of using the waters of the River Zomatlan for electric power purposes.

The Compania Electrica de Zacatecas, which was recently formed in Zacatecas to build and operate a modern electric light and power plant, has awarded the contract to Schoendube & Mengebauer, of the City of Mexico. As the power house will be located a mile from the center of the city, three-phase current at 3000 volts has been adopted. The work of installing the plant will begin early in the coming year. The firm whose name is herewith given is a responsible one and will need much material in the way of machinery, transformers and other equipment.

OBITUARY.

MR. WILLIAM B. RANKINE, vice-president of the Niagara Falls Power Company, died on September 30 at Franconia, N. H., whither he had gone for the benefit of his health. The immediate cause of his death was congestion of the lungs, superinduced by heart trouble. To Mr. Rankine and his associate, Mr. Edward D. Adams, was due more than to anyone else the modern utilization of Niagara on a grand scale. Mr. Rankine was one of the organizers of the Niagara Falls Power Company, and at the time of his death was also interested in a number of allied concerns. He was a graduate of Union College and was a member of the University Club, the Metropolitan Club and the Bar Association. He is survived by his wife, mother and three brothers.

MR. JOHN I. SABIN died very suddenly on October 10 in San Francisco. He had not been in good health for some time and was contemplating a six months' European tour, but this trip was not planned soon enough for him to realize any benefit from it. Mr. Sabin was born in New York State on October 3, 1847. In 1864 he entered the United States Army as a telegraph operator, moving to San Francisco at the close of the War in 1876, where he became an operator for the Western Union Telegraph Company. He took an active part in organizing the Bell telephone system on the Coast in 1878, and the remarkable development of the telephone in that section of the country was largely due to his fertility of resource and combative, progressive spirit. In May, 1901, he moved to Chicago and assumed the presidency of the Chicago Telephone Company. Two years later he became identified with the Pacific States Telephone Company, for which it is claimed that Mr. Sabin secured the highest percentage of telephones to population in the United States. Mr. Sabin was one of the leaders in electrical development on the Pacific slope, being widely known in the electrical field outside of telephony.

PERSONAL.

MR. W. J. MARLAND recently moved from New York to Chicago to assume charge of the Chicago office of the Gould Storage Battery Company.

MR. O. A. STRANAHAN, who joined the Allis-Chalmers Company in December, 1904, to become manager of the power department, has been appointed sales manager. His headquarters are at Milwaukee.

MR. HENRY M. BOWEN, formerly with H. M. Byllesby & Co., of Chicago, has been made general manager of the St. Louis, Hillsboro & Southern Railroad, with offices at 415 Locust Street, St. Louis, Mo.

MR. R. G. HUNT, formerly connected with the Fort Smith Gas & Electric interests, has been made manager of the Consolidated Gas & Electric Company, of San Diego, Cal., which is conducted under Byllesby auspices.

MR. E. T. SCHATTLE, heretofore connected with the Crouse-Hinds Company, of Syracuse, has accepted a position with the Crescent Electrical Manufacturing Company, of Rochester, where he will have full charge of the engineering department.

MR. G. A. NISBET, for several years sales agent for the General Incandescent Arc Light Company, and later of the Stanley-G. I. Electric Manufacturing Company, has been appointed general manager of the Charles A. Thompson Company, New York City.

MR. F. B. HUNTINGTON, secretary of the Eastern Wisconsin Railway & Light Company, has been elected vice-president of the company to succeed Mr. T. F. Grover, who recently resigned. Mr. Huntington will continue in his office as secretary for the present also.

MR. E. H. McHENRY, fourth vice-president of the New York, New Haven & Hartford Railroad, on October 1, took charge of the engineering department of the entire New Haven system. He formerly had supervision of the engineering department of the electrical division only.

MR. H. U. BADEAU has been appointed New York representative of the Switchboard Equipment Company, of Pittsburg, with headquarters at 30 Cortlandt Street. Mr. Badeau for several years past has been with the engineering department of the Western Electric Company in New York.

MR. G. F. BROCKMAN has resigned his position as electrical engineer and superintendent of the Hydro-Electric Light & Steam Power Company, of Jackson, Ala. He was the designer and builder of this installation which has made an unusually good record, having operated every night for fourteen months without a shutdown.

MR. WARREN F. HUBLEY, recently representative of the Sunbeam Incandescent Lamp Company, at Philadelphia, Pa., has resigned in order to accept the position of western representative of the American Transformer Company, of Newark, N. J. His headquarters will be with the Western Electric Company, Chicago, Ill.

MR. CHARLES L. SEEGER is now representing the Electric Storage Battery Company, of Philadelphia, in Mexico, his office being at Primera de Humboldt No. 10, Mexico City. Associated with Mr. Seeger is Mr. W. G. Davis, who has for some time been connected with the Electric Storage Battery Company in its Philadelphia sales office.

MR. ERRETT L. CALLAHAN has resigned his position as manager of the Prometheus Electric Company, of New York, in order to take charge of the electric heating work of the General Electric Company in the Chicago territory. Mr. Callahan was also formerly connected with the Simplex Electric Heating Company as assistant manager.

MR. M. C. MILLER, formerly connected with the Westinghouse Electric & Manufacturing Company, has been appointed assistant sales manager of the Allis-Chalmers Company. Mr. Miller joined the Allis-Chalmers Company a little over a year ago, and now takes charge of all matters in the sales department which do not require the personal attention of the manager.

MR. CHARLES W. LAWRIE, for several years general superintendent of the Ball Engine Company, Erie, Pa., and consulting engineer for many of the most important high-speed engine builders of the United States, has accepted the position of general superintendent of the Reeves Engine Company, of Trenton, N. J. Mr. Lawrie assumes his new duties on November first.

MR. KENNETH B. THORNTON, recently appointed operating manager of J. G. White & Co., has been made manager of the Nassau Light & Power Company, of Roslyn, Long Island. This company is managed and operated by J. G. White & Co. Mr. Thornton, previous to his association with White & Co., was connected with the Royal Electric Company, of Montreal, and the Montreal Light, Heat & Power Company.

MR. GEORGE K. WOODWORTH, for the past four years the examiner in charge of wireless telegraphy and long-distance telephony in the Electrical Division of the U. S. Patent Office, is now associated with Mr. Alexander P. Brown, of 31 State Street, Boston, Mass., under the firm name of Brown & Woodworth, attorneys-at-law. Mr. Woodworth will make a specialty of electrical patent matters in the Patent Office and in the U. S. Courts.

MR. C. A. GREENIDGE has been promoted from the position of superintendent of the electrical department of the Utica (N. Y.) Gas & Electric Company to that of general manager of that department. Mr. William J. Cahill, who has been general manager of the gas department and secretary of the company, has retired as secretary, and Mr. M. J. Brayton, whose place at the head of the electrical department Mr. Greenidge takes, has been appointed secretary.

MR. HARRY H. HORNSBY has accepted the appointment as sales manager of the conduit department of the Sprague Electric Company, New York, succeeding Mr. Alexander Henderson. He resigned the position of chief inspector of the Department of Electricity in Chicago to become sales engineer of the conduit department of the Sprague Company, which place he has held until his present advancement. Mr. Hornsby's extensive experience in the electrical business, both East and West, has qualified him to an unusual extent for his new position.

MR. CECIL B. SMITH, formerly chief engineer of the Niagara, Lockport & Ontario Power Company, and now in the employ of the Temiskaming & Northern Ontario Railway and the Ontario Hydro-Electric Power Commission, is making a tour of Europe for the purpose of investigating electric railway equipment abroad. He will study especially the electric locomotives of Italy, Switzerland, Germany, France and England. It is the intention of the Power Commissioners to equip the new Ontario Railway with electric locomotives in the near future, and they desire to investigate the feasibilty and practicabilty of such a road under the operating conditions which prevail abroad.

MR. B. J. JONES, formerly on the staff of Sargent & Lundy, consulting engineers, of Chicago, has accepted the managership of the electrical department of the Cincinnati Gas & Electric Company. He is well qualified for his new position, having in his former capacity come closely in touch with much of the electrical work of the Cincinnati Gas & Electric Company. Mr. Jones is the inventor of the flat flexible bond and solid terminal, designed to go under the fishplate, which was sold originally as the Atkinson bond. He is also the designer of many of the details of high-tension construction used in the Indianapolis & Cincinnati Traction Company's line between Indianapolis and Rushville, and adopted by the Westinghouse Electric & Manufacturing Company as standard construction for certain classes of single-phase trolley work. Previous to his connection with Sargent & Lundy, Mr. Jones was superintendent of the South Chicago City Railway Company, which position he accepted upon leaving a similar one at Sioux City, Iowa. He was also at one time with the Westinghouse Electric & Manufacturing Company.

MR. W. T. McCASKEY has joined the forces of the Allis-Chalmers Company and will act as a special representative where contracts are being considered for such work as the equipping of in-

terurban railroads, hydro-electric projects, etc. Mr. McCaskey was born in Richmond County, Wis., in 1863. His experience in electrical work began in 1882 as manager of the plant of the Eau Claire Electric Light & Power Company. Later he was connected with the Sperry Associate Electric Company, of Kansas City, Mo., and he operated the first electric lighting plant in Fort Worth, Texas, in 1885. From 1889 to 1894 he represented Edison and other interests on the Pacific Coast. He afterwards acted as representative of the Standard Electric Company, in Chicago, going to Buenos Ayres, South America, in 1899, for the Westinghouse Electric & Manufacturing Company and Agar, Cross & Co., where he remained until 1901. He was then Director in Spain and Portugal for the Societe Anonyme Westinghouse until December, 1903, and manager for Agar, Cross & Co., until May of this year. Mr. McCaskey will have his headquarters in Milwaukee.

TRADE PUBLICATIONS.

WIRING RECEPTACLE. Flyer No. 2166, illustrating a porcelain receptacle for moulding wiring brought out by the General Electric Company.

STORAGE BATTERIES. A small folder illustrating storage batteries for railway signal service brought out by The Westinghouse Machine Company.

TRANSFORMER FOR THAWING PIPES. The American Transformer Company issues this little pamphlet, illustrating and describing its transformer thawing outfits.

TRANSFORMERS. A price list and proposal form of standard lighting and power transformers, manufactured by the Pittsburg Transformer Company, Pittsburg, Pa., in sizes from .6 to 50 kilowatts.

TRANSFORMERS. This is bulletin No. 33 of the American Transformer Company, in which are illustrated and described the various types of high-voltage transformer manufactured by the company.

COMMON-BATTERY SWITCHBOARDS.—Folder No. 8 illustrating and describing the No. 2 Type of common-battery switchboard and its accessories, manufactured by The Dean Electric Company, Elyria, Ohio.

TELEPHONE CABLE. A booklet issued by the Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y., illustrating and describing the essential features of the line of telephone cable manufactured by the company.

MULTIPLE ENCLOSED ARC LAMPS. Supply catalogue No. 7591, illustrating and describing the parts of the edgewise parallel-rod, 110-volt, direct-current multiple enclosed arc lamp, forms 14 and 12, manufactured by the General Electric Company.

COMMON-BATTERY DESK TELEPHONES. A booklet entitled the "Brownie Bulletin," and containing a parody on "The House That Jack Built," the new type of desk stand manufactured by the Kellogg Switchboard & Supply Company being substituted for Jack's house.

CORLISS ENGINES. A catalogue of handsome design, published by The C. & G. Cooper Company, Mount Vernon, Ohio, and containing full-page illustrations made from photographs of representative plants in operation, which give an idea of the general design of the Cooper-Corliss engine.

INSULATORS. Supplement No. 1 to The Insulator Book which is issued by the Locke Insulator Manufacturing Company, Victor, N. Y. The supplement contains revisions and additions to the catalogue and is accompanied by an addenda sheet to be pasted in The Insulator Book.

HEATING APPARATUS. Catalogue No. 186 illustrating and describing "A B C" heating apparatus for the heating and ventilating of factory and public buildings and the drying of materials of all kinds. This apparatus is the product of the American Blower Company, Detroit, Mich.

BLACK AIR-DRYING VARNISH. This is a small pamphlet exploiting the Sterling black air-drying varnish manufactured by The Sterling Varnish Company, Pittsburg, Pa. The pamphlet also contains a list of other Sterling insulating compounds, together with a table of comparison of thermometrical scales.

MINING MACHINERY. A handsome catalogue issued by The Jeffrey Manufacturing Company and designated Bulletin No. 10, in which are illustrated and described the numerous types of electric mine locomotives manufactured by this company, together with their application to various uses and conditions.

RAILWAY LINE MATERIAL AND RAIL BONDS. A handsome, well-executed catalogue, No. 1049, from the General Electric Company, presenting a new list of railway line material devices manufactured by this company. The list comprises the numerous appliances required in railway line construction work.

THE JONES STOKER. A pocket edition catalogue illustrating and describing very fully the Jones under-feed mechanical stoker, of which The Under-Feed Stoker Company of America, Chicago, Ill., is the sole manufacturer. The catalogue also contains illustrations showing the method of equipping various types of boilers with the Jones stoker.

ELECTRICAL SUPPLIES. This is a general supply loose-leaf catalogue, in a substantial cloth binder, issued by the Commercial Electrical Supply Company, St. Louis, Mo. Accompanying the catalogue is a paper-bound price list and discount sheet. The catalogue covers fully the very complete line of electrical supplies of all kinds carried by the company.

ROTARY CONVERTERS. This is special publication No. 7038 from the Westinghouse Electric & Manufacturing Company, treating of Westinghouse rotary converters, their characteristics and construction, together with instructions for their erection, operation and care. The catalogue is fully illustrated and contains several diagrams of connections also.

MOTORS. Booklet No. 4120, containing illustrations and brief descriptions of automatic single-phase induction motors ranging in size from 1/40 to 1/2 horse-power, and bipolar and multipolar enclosed direct-current motors in sizes from 1/20 to 2 1/2 horse-power. These little machines are manufactured by The Emerson Electric Manufacturing Company, St. Louis, Mo.

SWITCHBOARDS FOR SMALL DIRECT-CURRENT PLANTS. Bulletin No. 409, containing illustrations, descriptions and price lists of switchboards for small direct-current plants, ranging in size from 5 to 20 kilowatts at 125 volts or from 10 to 40 kilowatts at 250 volts. The switchboards are manufactured by the Stanley-G. I. Electric Manufacturing Company.

PAISTE SPECIALTIES. Catalogue No. 12, illustrating and briefly describing the line of electric light supplies manufactured by H. T. Paiste Company, Philadelphia, Pa. The catalogue is conveniently compact and substantially bound in red cloth. The illustrative and descriptive matter includes the company's various types of sockets, receptacles, switches, rosettes, cut outs, socket fittings, etc.

INTERCOMMUNICATING TELEPHONES. Bulletin No. 13, illustrating and describing the various types of intercommunicating telephones, manufactured by the Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y. The bulletin deals exclusively with the central energy system with metallic circuits, and besides showing various types of apparatus, contains several representative diagrams of connections.

HARMONIC PARTY LINE SYSTEMS. This is bulletin No. 100, issued by The Dean Electric Company, Elyria, Ohio, which comprises a reprint of an article entitled "Concerning Harmonic Party Line Systems," by W. W. Dean, vice-president and chief engineer of The Dean Electric Company. The bulletin is well illustrated and the last five pages are devoted to the exploitation of the harmonic system manufactured by this company.

TABLES. These convenient tables are issued from time to time by the Warren Electric Manufacturing Company, Sandusky, Ohio, and are printed on cards of pocket size, the reverse sides of which bear illustrations of representative products of the company. Tables 11 and 12 give allowable pressures for steam boilers constructed of 1/4-inch single and double riveted plates respectively, while Table 17 gives an all-night street lighting schedule for the month of November.

CAR HEATING AND LIGHTING APPARATUS. A very complete catalogue of large size, containing illustrations and descriptions of the Gold Car Heating & Lighting Company's (New York) improved heating and lighting apparatus for steam and electric railways. The book also contains illustrations and descriptions of other railway supplies and gives numerous diagrams of the various heater equipments to meet different requirements. The catalogue is issued in two editions, one bound in red paper and the other in brown cloth.

BUSINESS NEWS.

THE IDEAL STOKER, 114 Liberty Street, New York, has secured the contract for installing Ideal stokers at the Bayonne (N. J.) works of the Para Recovery Company.

THE MOLONEY ELECTRIC COMPANY, St. Louis, Mo., will hereafter be represented in the East by The Electro-Dynamic Company, 11 Pine Street, New York City.

H. T. PAISTE COMPANY, Philadelphia, Pa., announces the opening of an office in Boston at 7 Otis Street, Winthrop Square. This office will be in charge of Mr. Frank Booth, who will also represent the New York Insulated Wire Company in that city.

C. H. M'GIEHAN COMPANY, automatic and special machinery experts, of No. 11 Broadway, New York, are distributing to their clientele a paper-mounted thermometer, on either side of which is printed a column of decimal equivalents, although the souvenir may be had without this.

CHANDLER & TAYLOR COMPANY, Indianapolis, Ind., reports the recent sale of one of its standard service enclosed self-oiling engines of the direct-connected type to the owners of the New York Life Building, Chicago, Ill.; also one of the same type, but made tandem-compound, to the University of Nebraska, at Lincoln, Neb.

BAY STATE LAMP COMPANY, of Danvers, Mass., is directing attention to the excellence of the renewed incandescent lamps manufactured by the company. The sale of these lamps is said to be increasing rapidly in spite of deep-rooted predjudice against renewed lamps. The company is making a liberal proposition to users of incandescent lamps who desire to make a fair trial of its product.

THE STANDARD ELECTRICAL MANUFACTURING COMPANY, Niles, Ohio, is distributing to its patrons a paper fac-simile of a pumpkin, bearing the features of a face, which may be converted into a Halloween lantern by hanging it over an incandescent electric lamp. On the inside of the sheet are some humorous lines in parody of James Whitcomb Riley's "When the Frost Is on the Punkin."

MACHADO & ROLLER, 203 Broadway, New York, selling agents for the Whitney Electrical Instrument Company, state that hereafter any recalibration, re-adjustment or repair of instruments that may be required within a period of one year after their sale will be effected by the company gratis, provided the instrument is returned prepaid with the seals intact. A paster to that effect is placed on each instrument.

THE SCHMIDT-WILCKES ELECTRIC COMPANY, 522 Gregory Avenue, Weehawken, N. J., announces that it has completed its organization as an independent telephone and switchboard manufacturer, with its plant located at Weehawken and offices at 135 William Street, New York City. The company has secured valuable telephone patents, under which its new product will be manufactured.

THE HOLOPHANE GLASS COMPANY, New York, was awarded the contract for the lighting fixtures in the new million-dollar court house at Syracuse, N. Y., perhaps the finest of its kind in the country. The new Holophane-Pagoda ball was adopted as a standard in 6-in., 7-in. and 8-in.

sizes, 900 of these being used on the decorative chandeliers. Over 2,000 Pagoda reflectors are to be employed for what is termed "the useful light" fixtures throughout the building.

THE COLONIAL FAN & MOTOR COMPANY, Warren, Ohio, reports the recent installation of twenty-five motors for The H. J. Heinz Company, of Pittsburg, Pa., for individual driving of can machinery and printing presses; also nineteen motors for the Kinnear Pressed Radiator Company, of West Pittsburg. Fourteen large motors have just been shipped to the Independent Packing Company and the Chouteau Avenue Ice & Cold Storage Company, of St. Louis, Mo.

THE ONEIDA COMMUNITY, LTD., Oneida, N. Y., is putting on the market a special chain for rasing and lowering arc lamps suspended from mast arms. The chain is made in various sizes to fit any pattern of pulleys and will, it is claimed, out-wear two or three times over any other attachment which has yet been put on the market for this purpose. We understand that the Oneida Community, Ltd., is prepared to send a sample complete, ready to put on an arc light, to any central station who will apply for same.

G. M. GEST, subway contractor of New York and Cincinnati, has been awarded a contract for the construction of a complete electrical subway system for the Dayton Lighting Company, Dayton, Ohio. This plant has recently been acquired by new interests, who are rebuilding and reequipping the whole plant. The contract given to Mr. Gest is for subway installation for the whole city, covering twenty miles of streets and involving over a million feet of conduit. The system is to be absolutely modern and up to date, and will cost in the neighborhood of $250,000.

STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., reports having closed contracts for switchboards for the following places: Roxboro, N. C.; Onaga, Kan.; Rochester, N. Y.; Ellicottville, N. Y.; Eldorado, Ark.; Wabash, Ind.; Newark Valley, N. Y.; Camden, N. J.; Sonora, Ky.; Minneapolis, Minn.; Pattersonville, N. Y.; Des Moines, Ia.; Seward, Ill.; Sublette, Ill.; Little Valley, N. Y.; Beloit, Kan.; Milbank, S. D.; Wheeling, W. Va.; Linn Grove, Ind.; Brooton, Minn.; Abbott, Tex.; Vertrees, Ky.; Payette, Ida.; Hammonton, N. J.; Chenoa, Ill.; Tiskilwa, Ill.; Swedenboro, N. J.

THE BALL & WOOD COMPANY, steam engine builders, 17 Battery Place, New York, has recently added to its works at Elizabethport a plant for turning out welded flanged pipe and pipe bending. The company will do no pipe fitting and undertake no piping contracts, but is prepared to quote prices and fill orders for the material used in this work. In its new plant The Ball & Wood Company has endeavored to avail itself of the latest improvements in every line of equipment, not only in making the joints and bends, but in handling the material. To distinguish it from others on the market, the company has given its trade name, "Ballwood," to this joint.

WILLIAM ROCHE DRY BATTERY COMPANY is the name of the firm, recently incorporated with a capital of $25,000, which succeeds to the business conducted by William Roche, since 1897, at 52 and 54 Park Place, New York City. Mr. Roche is president of the new corporation, and has associated with him Messrs. C. Laton Ford, formerly first vice-president of the Celadon Roofing Tile Company, New York; Mr. Ernest A. Lowe, president of The Lowe Electric Company, and William C. Hubbard, for a number of years with the Westinghouse Electric & Manufacturing Company. Mr. Lowe is vice-president, Mr. Ford treasurer, and Mr. Hubbard secretary of the company.

THE NEW PROCESS RAWHIDE COMPANY, Syracuse, N. Y., has announced its intention of going more extensively into the manufacture of metal gears of all kinds, as well as its well-known "New Process" noiseless pinions. For this purpose the company has just completed a two-story brick addition, containing about 10,000 feet of floor space, and is installing a number of additional turret lathes, drills, grinders, spur gear cutters, bevel gear planers, and other machines necessary for the manufacture of accurate gearing. This additional equipment will increase the company's capacity about 75 per cent. Its business is reported as very brisk, shipments being already considerably in excess of last year.

THE WESTINGHOUSE MACHINE COMPANY notes an increasing demand for the gas engine, and has received within the last few weeks orders for these machines ranging from 10 to 1,000 b.h.p.; the orders include thirty-six engines, aggregating 6,647 b.h.p. The company has also received from the Public Lighting Commission of the City of Detroit, Mich., orders for two 2,000-kw. turbine-type generator units for installation in its power house on the river front in the center of the business district of the city. Three large orders for Roney mechanical stokers have recently been placed with the company, one from the Jones & Laughlin Steel Company, of Pittsburg, one from the Lehigh Valley Traction Company, of Philadelphia, and another from the Pressed Steel Car Company, of Pittsburg, besides one from the Pennsylvania Railroad Company for its shops at Altoona, and numerous smaller orders from various parts of the country.

THE PELTON WATER WHEEL COMPANY, San Francisco, Cal., states that owing to the steady growth of its business it is obliged to enlarge its works, and to that end has purchased a block of land in South San Francisco, where a modern machine shop is now under course of construction. This new shop will be equipped with the latest high-grade tools and handling devices, affording exceptional facilities for the construction of high-grade apparatus. The company recently closed a contract with the Oro Water, Light & Power Company, Oroville, Cal., for two complete Pelton units of 2,000 horse-power each, direct-connected to electric generators, the wheels operating under a 465-ft. head. Among other recent orders are: A wheel equipment for the Crown Columbia Paper & Pulp Company, of Washington, consisting of a triple Pelton unit for direct-connection to heavy pulp grinders; a 300-h.p. unit for Takata & Co., of Tokio, and a large wheel for the Ingersoll-Sergeant Drill Company for direct connection to one of their compressors.

CENTRAL STATION NEWS

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

ALABAMA.

COURTLAND.—It is reported that Lawson, Sykes & Co. want prices on machinery and equipment for an electric light plant.

ARIZONA.

BENSON.—It is proposed to organize a company under the name of Benson Light & Water Company, with a capital of $5,000. Doan Merrill is interested.

CLIFTON.—The two large mining camps of Clifton and Morenci, Arizona, are to have electric power to operate both smelters. The Caledonian Coal Company, Gallup, New Mexico, owners of the smelters, is preparing to undertake the project.

ARKANSAS.

LITTLE ROCK.—Springdale has granted a franchise for an electric light plant to Spencer Owen of Belgrade, Neb.

ARGENTA.—C. J. Humphreys and others have been appointed a committee to select a site for the new electric light plant, to be erected by the municipality.

MENA.—The Mena Light, Heat & Power Company has been incorporated with a capital of $250,000, to own and operate a heating and lighting plant, in addition to cold storage and other utilities. Incorporators: Francis R. Hoyt, Willston D. Hoyt, and others.

VAN BUREN.—The Van Buren Electric Light & Power Company has been incorporated with a capital of $25,000. The incorporators are John E. Powers, Henry L. Fitshugh and Sydney A. Pernot. The company will operate a plant to furnish electric lights in this city.

CALIFORNIA.

AUBURN.—At a meeting of the city trustees it was decided to sell the old gasoline street lights and install electric arc lights.

DOWNIEVILLE.—W. Dubuque has purchased the interest of Tony Costa in the local electric light plant.

SACRAMENTO, E. J. Carragher, it is reported, is clerk of a committee appointed to find ways and means of establishing a municipal lighting plant.

OAKLAND.—The Northern Water Power Company has been incorporated by H. L. Atkinson, Charles P. Pritchard and others of Oakland, with a capital stock of $5,000,000.

MAYFIELD.—The municipal electric light system has been abandoned and the town trustees have contracted with the Redwood City Electric Company to furnish power for street illumination.

SAN FRANCISCO.—The West Coast Electric Light & Power Company has been incorporated with a capital stock of $25,000 by J. F. Hathaway, T. F. Fogelsang, C. R. Lundberg, W. T. Hume and C. Ulmer.

LOS ANGELES.—The Pacific Light & Power Company is preparing to develop electric power in Yavapai County, Ariz. The initial installation will consist of a 1,200-h.p. hydro-electric plant, which it is expected will be increased to 6,000 horse-power eventually.

SAN FRANCISCO.—The Union Power & Light Company has been incorporated with a capital of $2,000,000. Directors: John Martin, M. Fleishhacker, R. E. Wallace and H. A. Cook, of San Francisco; Frank H. Brack, of Vacaville; John Humphrey and R. Kirman, of Reno.

LOS ANGELES.—The Valley Electric Company has been incorporated by R. F. Davis, E. A. Miller and A. Morris of Los Angeles, and T. D. Allin and E. Galbraith of Pasadena. The organizers of the company had already secured an electric lighting plant at Santa Maria, Cal., and the company was organized to take over and operate this property.

SAN FRANCISCO.—The California Gas & Electric Corporation recently gave to John Martin & Co. two orders of 7-strand aluminum cables, aggregating 150,000 lbs., for use on its extensions. An additional 45-mile, three-phase transmission line will be built between San Francisco and San Jose. Six-naught cable, of 350,000 circ. mils will be used. The other order, consisting of No. 1 aluminum, will be used on a new branch transmission line, tieing in near San Jose and extending 40 miles to the cement works of the Santa Cruz Portland Cement Company's new plant at Davenport, Santa Cruz County. Power will be supplied for the manufacture of about 5,000 barrels of cement per day. The company is also installing one of the three frequency-changers, which are to be located in the new gas engine reserve plant, near San Francisco. It is the intention to start up the new frequency-changer in November and deliver current to the railways so that the engines can be shut down in the Eleventh and Bryant Street power station, which is being converted into a sub-station.

SAN FRANCISCO.—The Nevada Power, Mining & Milling Co.'s electric power plant on Bishop Creek, Inyo County, Cal., has gone into commission after making a good record for construction. One of the two 750-kw., three-phase National

Electric generators of the initial installation is in successful operation, supplying lights in Tonopah and Goldfield, Nev. The second generator is being installed. A Pelton water wheel, operated under a head of 1,064 ft., is direct connected to each generator. The transmission line extends 85 miles to the junction at Alkali Springs, where it branches, the distance thence to Tonopah being 18 miles, and to Goldfield, 10 miles. An elevation of 10,000 feet is reached in crossing the White Mountains. An additional Bullock generator, of 1,500 kilowatts capacity, will be delivered by the Allis-Chalmers Company about December 1 and connected to a Pelton water wheel. The home office of the company is in Denver, Col.

YREKA.—Since the consolidation of the Siskiyou and Yreka electric light and power plants, many changes have been made, with more contemplated for greater capacity. At present the old Yreka plant at Shasta River, will be used for lighting purposes in supplying Yreka, Fort Jones, Greenview, Etna, etc., while the Siskiyou plant at Fall Creek, Klamath River, will supply all the power used and the lights at a number of places in Shasta Valley, and be taxed with 400 horse-power for the operation of the Montague box factory and the Yreka Creek dredger. A couple of large transformers have been sent over to Humbug, where about 40 horse-power will be used for the new Mono quartz mill. The Siskiyou Company is also putting in a large new dynamo at Fall Creek, which will increase the capacity of that plant from 700 to 2,000 horse-power, and there is 400 horse-power at the Shasta River plant, which makes a capacity of 2,400 horse-power. When the new dynamo is installed the two plants will be joined for supplying both systems, with expectation of extending wires to all other sections of the country, where needed.

SAN FRANCISCO.—The Northern Water & Power Company has been formed by H. L. Atkinson, C. P. Pritchard, T. A. Allan and others; the capital is $5,000,000.

SANTA MARIA.—The Isaac Springer Investment Company, of Los Angeles, has purchased the Santa Maria Light & Power Company, and contemplates extending its lines to Guadulupe.

SAN FRANCISCO.—The General Electric Power Company, of San Franicsco, has been incorporated with a capital stock of $1,000,000, by J. P. Lucey, W. E. Cashman, W. T. Love and K. J. C. Seymour and Guy C. Calden.

COLORADO.

ROCKVALE.—The Council is reported to have granted the Arkansas Valley Electric Light Company a franchise to construct and operate an electric light plant.

GREELEY.—The Home Electric Light & Power Company will increase its capitalization from $4,500 to $50,000. The company, which is composed of professors in the State Normal School, and others, has conducted a small electric light plant in the vicinity of the State Normal School so successfully that it will enlarge the plant to supply the entire town. A franchise was granted to it recently.

DENVER.—It is stated that improvements costing nearly $1,000,000 are to be made by the Denver Gas & Electric Company to its plant during the coming year. Next spring in the plant at Sixth and Lawrence streets a new Curtis 3,000-kw. turbine is to be installed. Later on in the year a similar turbine is to be installed in this plant. New machinery costing about $150,000 to replace worn-out apparatus is to be purchased by the company. The building is to be enlarged at a cost of about $45,000. Four 500-h.p. boilers are to be installed.

DELAWARE.

WILMINGTON.—An electric light line will be run from New Castle to Delaware City to furnish light to the latter place.

FLORIDA.

MAYO.—The Town Council has granted Clarence H. Ellis and associates a franchise for the construction of an electric light plant and water works.

KEY WEST.—An ordinance is stated to have passed first reading, granting to Messrs. Ladd, Larkins and Jerguson, a franchise to furnish electric light to Key West.

GEORGIA.

COLUMBUS.—The City Council, it is stated, is considering the cost of a municipal electric light plant.

ROCKMART.—B. Stark, City Clk., writes that it is proposed to construct an electric light plant to cost about $7,000.

COCHRAN.—Bids for the purchase of $17,000 electric light and water bonds are wanted at once. Address Dr. T. D. Walker, chairman of the bond commissioners.

OCILLA.—The Mayor and Board of Aldermen are stated to have awarded to Engineer J. B. McCrary, of Senora, the contract for water works and an electric light system, to cost about $28,000.

MONTICELLO.—The town of Monticello has bought the electric light plant, the property of B. Jordan, and will operate it in connection with the water works system, using electric power for pumping the water. The two plants will be operated together.

LAWRENCEVILLE.—J. W. Chapman, of Lawrenceville, has secured an option on a water-power near Brevard, N. C., and proposes to develop the same, and will build an electric light plant to supply the town of Brevard, and the Transylvania Railroad.

IDAHO.

RATHDRUM.—The Rathdrum Light & Power Company has been reorganized and will hereafter be known as the Rathdrum Electric Company. The ownership is the same as before.

LEWISTON.—The Clearwater Irrigation, Land & Boom Company has been incorporated with a capital of $150,000, by H. L. Pittock and F. W. Leadbetter, of Portland, Ore., and L. A. Porter, of Lewiston.

ILLINOIS.

STREATOR.—The city of Streator is talking of putting in a public electric light plant.

NASHVILLE.—K. K. Steinhauser has purchased the Nashville electric light plant from the former owners.

HILLSBORO.—Hillsboro Electric Light & Power Company, has increased its capital stock from $5,000 to $50,000.

PLANO.—The Plano Heat, Light & Power plant is now the property of E. J. Kreis, of Mendota, and E. Lindner, of Milford, Ill.

DEPUE.—The village of Depue is to have an electric lighting plant. A franchise for this purpose was granted at a recent meeting of the town board.

FREEBURG.—Plans and specifications have been completed by Owen Ford, of St. Louis, Mo., for the proposed municipal electric light and power plant, to cost about $9,000. Charles Keessler is village clerk.

BREESE.—The Breese Water & Light Company is preparing to install a central lighting plant. William H. Bryan, Lincoln Trust Building, St. Louis, Mo., is the consulting engineer in charge of the work.

SALEM.—The village board of Odin has granted a twenty-year franchise to the Odin Coal Company, for the operation of an electric light plant, and the village has contracted for forty arc lights for street lighting at $50 each.

FISHER.—The Fisher village board of trustees has awarded to the Wardlow Electric Lighting Company a franchise, which provides that the company shall light the streets of the village with twelve arc lights of 1,200 candle-power each at $50 a month.

ROCKFORD.—At a meeting of the stockholders of the Central Heat & Power Company at the company offices it was decided to double the capacity of the lighting plant, and the directors of the company were empowered to at once open negotiations for the purchase of a new 500-h.p. engine and generator.

CHICAGO.—John H. Radford is preparing plans for an addition to an electric light plant at Fifty-eighth street and Cottage Grove avenue, Washington Park, for the south park commissioners, who will take figures when the plans are ready. It will be one story, of brick and stone, with slate roof. The commissioners expect within two or three years to build a central electric light plant with sufficient capacity to light the entire park system. It will cost about $200,000. D. H. Burnham & Co. are the architects.

MOUNT VERNON.—A largely attended meeting was held Oct. 2, to take action on the increased scale of charges made by the Citizens' Gas, Electric & Heating Company, for its utilities, the company having refused to adopt the scale of charges recently made by Ordinance of the City Council, which had come to the rescue of the people. The people will tender the old scale of charges. A committee of citizens has been appointed to represent the public and to defend any suit brought by the company, and public supscriptions will be taken up to pay counsel in case of litigation.

INDIANA.

CRAWFORDSVILLE.—J. F. Davies, of Toledo, Ohio, has secured the contract for repairing the city electric light plant at $7,433.

GREENWOOD.—The Citizens' Water & Light Company has been incorporated with $25,000 capital stock. The directors are David E. Demott, John W. Henderson and James A. Craig.

WEST TERRE HAUTE.—The town trustees have granted the West Terre Haute Light & Power Company a franchise to construct and operate an electric light plant. Claude Erwin is one of the incorporators.

SHELBYVILLE.—The Shelbyville Water & Electric Light Company's plant has been purchased at receiver's sale by C. F. Street, of New York, the consideration being $36,000. Mr. Street will at once improve the property, retaining Mr. F. M. Nichols as superintendent.

SCOTTSBURG.—The City Council has granted a franchise to James Smith for an electric light plant and a franchise to Joseph Shea for a water works plant. Messrs. Shea and Smith will join their franchises and put up one plant that will furnish electric light and water instead of having two separate plants, and work will begin on the building as soon as plans can be perfected and the contract let.

HUNTINGTON.—The Huntington Light & Fuel Company is installing two 200-kw., 60-cycle, 2,300-volt General Electric generators and switchboard to replace its 125-cycle, 1,040-volt apparatus. The company will furnish current to the Erie Railroad for light and power in the shops at Huntington. The company has also just closed a contract to supply steam for heating the court house now being erected at Huntington.

INDIAN TERRITORY.

ATOKA.—The Atoka Light & Power Company will spend about $10,000 in improvements, it is said.

HOLDENVILLE.—The Chas. DeWatteville Electric Light & Ice plant, valued at $25,000, was destroyed by fire. The plant will be rebuilt without delay.

VINITA.—The power plant of the Vinita Electric Light, Ice & Power Company is reported to have been destroyed by fire on Sept. 26, with a loss of $5,000.

MUSKOGEE.—G. W. Sargent, of Joplin, Mo., is stated to have petitioned for permission to construct a power plant to replace the one recently destroyed by fire.

IOWA.

DES MOINES.—Dayton Heat & Light Company has been incorporated with a capital of $10,000.

SPIRIT LAKE.—The proposition to sell the municipal electric light plant was defeated at a special election.

FORT MADISON.—Several thousand dollars' worth of new machinery is being installed in the electric light plant here.

AFTON.—The Council is reported to be considering the question of constructing a municipal electric light plant, or of granting a franchise for the plant.

CHARLES CITY.—The electric lighting plant has been sold by H. V. Russell & Co., to F. O.

Martin, of Floyd, and A. L. Dodd. A number of extensive improvements are planned.

WEBSTER.—Mr. R. B. Leroy, in behalf of outside capitalists, has offered the city of Webster $100,000 for the municipal water, heat, light and gas plants and a street car franchise.

KANSAS.

PAOLA.—By a close vote this city has voted $25,000 in bonds for the building of a municipal electric light plant.

MINERAL.—The Sun's Rays Electrical Company has asked for a franchise to install an electric light plant here.

CHAPMAN.—The Chapman Milling, Elevator & Electric Light Company has been incorporated with a capital of $30,000.

MENA.—The Mena Light, Heat & Power Company has been incorporated with a capital of $250,000 by Francis R. Hoyt and others.

OSBORNE.—Frank A. Higley, of Cummings, Kan., has asked the City Council for an electric light franchise, and proposes to put in a lighting plant here if given a free site for his power house.

GARNETT.—The Garnett electric light plant has changed hands and is now owned by Dr. Milligan, J. Stevenson, J. F. Delinger, C. H. Rice, P. E. Keeney, J. W. Bronston and Leper Adams. J. F. Delinger is president of the company, J. W. Bronston, secretary, and J. H. Stevenson, treasurer and manager

KENTUCKY.

PIKEVILLE.—The Pikeville Electric Light Company has been incorporated with a capital of $50,000 to operate an electric light plant.

HOPKINSVILLE.—John H. Bell, Jr., of Hopkinsville, is stated to have secured a franchise for the construction and operation of an electric railway and electric light plant.

MOUNT STERLING.—Cincinnati capitalists have closed a contract with J. W. Riley, of Morehead, to erect a modern electric light plant in that city at once. The plant will cost $15,000.

WILLIAMSBURG.—Gleaves & Company, of Lynchburg, Va., propose to construct and own water works and an electric light plant at Williamsburg, to cost about $45,000. J. A. Gilman is the engineer.

COVINGTON.—The National Construction Supply Company, of St. Louis, Mo., has submitted to the light committee of the General Council a proposition to install an electric light plant, with duplicate machinery of sufficient capacity to supply 400 arc lights of 2,000 candle-power and 2,000 incandescent lights, for $75,000.

LOUISIANA.

NEW ORLEANS.—Work on the Consumers' Electric Company's new plant is progressing rapidly.

CHARLES CITY.—Martin & Dodd have purchased the electric light plant, and will put in a heating plant.

MAINE.

DEXTER.—The Dexter Electric Light Company has sold its plant and business to N. Curtis Fletcher, of Boston.

LEWISTON.—The Lewiston & Auburn Electric Light Company will make a further reduction in rates to all its customers, upon meter service. The reduction is from 10 cents per kilowatt-hour to 9 cents per kilowatt-hour.

PORTLAND.—The International Paper Company has brought a bill in equity in the United States Circuit Court here against the Bodwell Water Power Company of Old Town, asking the court to restrain the latter company from erecting and maintaining dams on the Penobscot River and the Stillwater branch.

ELLSWORTH.—The City Council has taken action which will enable a company of which W. H. Buhlen, of Boston, Mass., is the head, to build a dam across Union River. The company proposes furnishing power to the industries of Ellsworth, Bar Harbor and vicinity. The probable cost of the proposed plant is $1,000,000.

EASTPORT.—The Copen Light & Power Company has been organized at Eastport, for the purpose of generating and supplying gas and electricity for lighting, heating and mechanical purposes in Perry, Pembroke and Dennysville, in Washington County, Maine, with $10,000 capital stock. The officers are: President, Chas. E. Copen, of Eastport; treasurer, Charles H. Emery, of Eastport.

BUCKSPORT.—There are rumored plans for the development of an electric power plant at Orland upper falls. Recently an expert has been making estimates of the extent of the power, the storage of water, the size of the watershed, the annual rainfall, etc., and the result of these will no doubt warrant the expenditure of many thousands of dollars in the construction of dams, acquirement of flowage rights, purchase of real estate, besides the construction of buildings, installation of machinery, etc.

MARYLAND.

MIDLAND.—The Consolidated Coal Company, it is stated, will erect a plant at Ocean Mine, No. 1, with power enough to supply light to the town of Midland and surrounding places.

ROCKVILLE.—At a special meeting of the mayor and council of Rockville a contract was entered into with Anderson Offutt, H. Worthington Talbott and David M. Munro for the rehabilitation of the lighting plant.

BALTIMORE.—Subway Engineer Phelps will start at once the construction of a conduit line to Westport to connect with the power house of the United Electric Light & Power Company. The line will be about 11,000 feet long and will be laid in South Fremont avenue and Ridgeley street.

MASSACHUSETTS.

SOUTH HANSON.—A new company will soon be incorporated in this town, known as the Hanson Gas & Electric Company, with W. E. Damon as president.

SOUTH HADLEY.—The Holyoke Water Power Company, of Holyoke, has petitioned the selectmen of South Hadley for permission to erect poles and string wires from Holyoke to South Hadley Center.

MEDWAY.—The Kendall Construction Company, of Boston, has been awarded the contract by the Medway Electric Light & Power Company to entirely reconstruct its street and commercial lighting systems in this city.

BOSTON.—At the annual meeting of the Edison Electric Illuminating Company, of Boston, held on October 10, one of the matters considered was the sale of the Milton plant, acquired when the property of the old lighting company in that town was absorbed. The plant is no longer needed, electricity being furnished from the South Boston plant. The company's management also asked for authority to finance some of its undertakings by the borrowing of money secured by a short-time mortgage on real estate held by the company. The company has just taken title, in accordance with prior agreement, to the property in Head Place, off Boylston street, which it has occupied since starting in business. Upward of $300,000 is involved in the deal. Last July the company acquired adjacent property out to Boylston street, and changes are contemplated therein which will make of the several parcels a compact and commodious central structure for display headquarters and for offices of the company.

MICHIGAN.

DETROIT.—The Detroit Edison Company has acquired the Grosse-Pointe Farms electric lighting plant, which supplies a suburb of Detroit.

LANSING.—The Piatt Power Company, of Lansing, has purchased the water privilege at Grand Ledge and will erect a power house there.

L'ANSE.—The plans of Liebert & MacNeil, of Calumet, are stated to have been accepted for the municipal electric light plant; probable cost, $10,000.

DETROIT.—The National Gas, Electric Light & Power Company is negotiating for the purchase of the Niles Gas Company's plant and the one at Warsaw, Ind.

SOUTH LYON.—The village of South Lyon has bought the electric light building and equipment of J. R. Blackwood, and will run its own lighting system hereafter.

MONROE.—The Monroe Council has appropriated $5,000 for the rewiring of the city and for installing electric meters. This is the first step toward improving the municipal lighting plant. The River Raisin will furnish the necessary power.

HOUGHTON.—The Great Northern Power Company will have its plant and equipment installed to furnish electrical power to the mines of the Mesaba range by the fall of 1906. A number of the mines have signified their intention to utilize electric power wherever possible.

ELK RAPIDS.—Arthur McMillan, of Toledo, has been granted a franchise for a commercial lighting plant in Elk Rapids. The village is to have not less than 25 arc lights at $75 per light, and above 25 lights the charge is to be $70 per light, on a moonlight and two o'clock schedule.

MINNESOTA.

MINNEAPOLIS.—An electric light plant will be established at Mahnomen.

BELLE PLAINE.—It is stated that the Council has voted to install a municipal light plant.

FANNING.—An electric light plant and waterworks are to be established in this city in the near future.

BLUE EARTH.—W. S. Belt has succeeded F. A. Ross as superintendent of the Blue Earth electric light plant.

BEMIDJI.—The Warfield Electric Company has installed a 24-hour service at Bemidji, and is furnishing an electric service for power to its patrons.

ELLENDALE.—The Ellendale Milling & Light Company has been organized and will build a mill and electric light plant there. Frank Kycek is president and H. L. Dodge secretary.

LE ROY.—It is reported that the electric light plant, recently destroyed by fire, will not be rebuilt until spring, but a dynamo will be installed in the mill to furnish electricity for the present.

ST. CLOUD.—Samuel S. Chute, with four assistant engineers, is reported to have commenced a permanent survey for the Whitney dam across the Mississippi River. It will probably be 550 feet in length and cost about $50,000.

WILLMAR.—J. T. Otos, City Clk., writes that W I. Gray & Co., of Minneapolis, have secured the contract for an engine, 120-kw. alternator, and steam and electrical appliances for the addition to the water and electric light plant for $5,300.

DULUTH.—The Great Northern Power Company is reported to have awarded to the Chicago Bridge & Iron Company, of Chicago, Ill., the contract for the erection of a steel standpipe 232 feet high, to be used in connection with its work of developing the water power on St. Louis River.

ST. PAUL.—A mortgage executed by the St. Croix Falls Improvement Company to the City Trust Company, of Boston, for $2,000,000, has been filed with the registrar of deeds. Bonds in the sum of $1,000 each, bearing five per cent. and due in thirty years, will be issued. It is recited that the loan is made for the purpose of getting a right of way for the construction and equipping of an electric transmission line from the power house of the company to Minneapolis, and for the purpose of constructing a distributing system in Minneapolis and elsewhere. A massive dam is being constructed at St. Croix Falls which will furnish power to Minneapolis, and in time to a number of other cities of the state.

MISSOURI.

EDINA.—The Edina Light Company has been incorporated, with a capital of $10,000, by Fred J. Wilson, Jane D. Wilson and Paul K. Gibbons.

COLLINSVILLE.—The Collinsville Gas, Electric & Refrigerator Company has been incorporated by Charles F. Slocum, of Belleville, John H. Seigel and W. E. Hadley, with a capital of $50,000.

WARSAW.—At a special election held recently the proposition to issue bonds to the amount of

$6,000 to build and maintain a municipal electric light plant was carried. The present plant has proved inadequate.

JERSEYVILLE.—Mr. R. W. Bivins, Springfield, Ill., has been appointed superintendent of the electric light plant owned by the Jerseyville Illuminating Company, to succeed Mr. J. J. Miller, resigned. Mr. Bivins was formerly connected with the lighting plants at Decatur and Arcola, Ill.

MONTANA.

HELENA.—A certificate of its articles of incorporation has been filed with the county clerk by the Helena Light & Railway Company, which has taken over the system of the Helena Light & Traction Company. The incorporators of the company, which is capitalized at $1,500,000, are Louis Sperry, of South Windsor, Conn., and Warren B. Johnson and Harry W. Reynolds of the same state.

NEBRASKA.

HOOPER.—William T. Martin has sold out his electric light business to W. A. Hough.

WISNER.—The town authorities of this city have awarded the contract for an electric light plant to cost $5,100.

HASTINGS.—The municipal electric light and power plant is being enlarged by the addition of a 400-h.p. engine and generator, costing between $15,000 and $20,000.

GRAND ISLAND.—The Grand Island Electric Company has been incorporated with a capital of $60,000 by Arthur F. Vila, G. H. Payne, Irving F. Baxter and others.

FREMONT.—The Fremont Gas and Electric Light Company of Fremont, Neb., has been bought by L. P. Funkhouser and other Lincoln men.

RAVENNA.—The village trustees are considering the question of constructing an electric light plant.

NEVADA.

ELKO.—The Intermountain Power Company is reported incorporated with a capital of $1,500,000 by E. J. Raddats, C. O. Ellingwood and W. J. Craig, to construct a power plant at this place.

NEW HAMPSHIRE.

KEENE.—The stockholders of the Citizens' Electric Company of this city have voted to increase the capital stock of the company from $35,000 to $50,000.

MEREDITH.—The directors of the newly organized Meredith Electric Light Company, residents of Providence, R. I., have decided to increase the capital stock of the company from $9,000 to $16,000, and to change the system to an alternating one. The power house at Meredith will be done away with, and power brought from Laconia.

EXETER.—The deed conveying the plant, business, good will, etc., of the Frank Jones Electric Company to the Rockingham Light & Power Company, a subsidiary company of the New Hampshire Traction Company, has been recorded. This company operated in Portsmouth, Newcastle and Rye, and the deed was executed by the trustees of the Jones estate.

NEW JERSEY.

NEW BRUNSWICK.—There is talk of a municipal electric light plant here owing to some dissatisfaction with the rates and service of the Public Service Corporation.

GLOUCESTER CITY.—The electric light plant of the Public Service Corporation and the powerhouse of the Camden, Gloucester & Woodbury trolley road, which is a part of the Public Service, are about to be closed, and the power for the electric lights and trolley road will be supplied from the Camden plant.

NEW MEXICO.

SANTA FE.—The City Council of Silver City has entered into a contract with the New Mexico Light, Heat & Power Company for the furnishing of lights to the city by said company for a period of two years, with the privilege of renewing the contract from year to year for a period of five years from date. The price for all lights now installed is to be 90 cents per light per month, and $1.50 per light per month for any additional lights the city may desire.

NEW YORK.

ALBANY.—The Chatham Electric Light Company has extended its line to Ghent.

LOCKPORT.—The Economy Light, Heat, Power & Fuel Company is stated to have petitioned Council for a franchise.

AUBURN.—The Auburn Gas Company has decided to purchase the plant and franchise of the Citizens' Light & Power Company, of Auburn.

AKRON.—The Niagara, Lockport & Ontario Power Company has filed with the Akron town clerk an acceptance of the franchise granted to it recently.

BUFFALO.—The Niagara, Lockport & Ontario Power Company has been granted a franchise by the town board of Newstead for a transmission line through that town.

HERMON.—The State Commission of Gas and Electricity has granted the application of the Hermon Electric Light Company to transact business and issue $15,000 of stock.

PHOENIX.—The Phoenix Fuel, Light & Water Company is reported to have been granted permission by the State Commission of Gas and Electricity to issue $100,000 bonds.

BINGHAMTON.—The trustees of the village of Port Dickinson have closed a contract with the Binghamton Light, Heat & Power Company for electric light service for the village streets.

ALBANY.—The Tremont Mills Utility Company, of New York, has been incorporated to supply electricity for light, heat and power. The directors are: S. K. Jacobs, C. A. Jacobs and E. L. Jacobs, of New York.

SOUTH GLENS FALLS.—The Bd. of Village Trustees is reported to have awarded the United Gas, Electric Light & Fuel Company the contract to light the village streets for five years, with 2,000-c.p. arc lights at $50 per light per year.

NEW YORK CITY.—The New York Edison Company reports that there are now connected with its mains in Manhattan motors aggregating 100,275 horse-power. Among new or pending contracts for the service of the Edison company is a supply of current for the New York Custom House. Contracts for the equipment of this building were announced recently.

UTICA.—Mr. C. A. Greenidge, who has been superintendent of the electrical department of the Utica Gas & Electric Company, has been promoted to the position of general manager of that department. Mr. William J. Cahill, who has been general manager of the gas department and secretary of the company, has retired as secretary, and Mr. M. J. Brayton, whose place at the head of the electrical department Mr. Greenidge takes, has been appointed secretary.

SYRACUSE.—The Syracuse Lighting Company is about to close a contract with the Niagara Falls Power Company for 10,000 horse-power. It is said that this is done for the purpose of forestalling competition. The transmission company, which is now engaged in securing rights of way, has reached as far as Monroe County. By March 1, power from Niagara Falls is expected to be operating the Rapid Transit Railway system in Syracuse, where a large sub-station will be built.

NIAGARA FALLS.—The Niagara Falls Power Company announces the following changes, occasioned by the death of the late William B. Rankine; Mr. deLancey Rankine has retired from the office of third vice-president of the power company, and it is understood that at its first meeting he will be chosen to fill the vacancy in the board of directors caused by the death of William B. Rankine. Mr. De Lancey Rankine will devote all of his time to the affairs of the Cataract Power & Conduit Company, of which company he is both treasurer and secretary. Mr. Philip P. Barton, heretofore superintendent of the Niagara Falls Power Company, has been appointed general manager of the business and operations of the company at Niagara Falls. The office of second vice-president remains unfilled.

NORTH CAROLINA.

LOUISBURG.—The question of constructing a municipal electric light plant is reported under consideration here.

GREENSBORO.—The Greensboro Electric Company has improvements to its plant under way, requiring the expenditure of $50,000.

MOREHEAD CITY.—It is stated that Cincinnati capitalists have closed a contract with J. W. Riley, of this city, to erect an electric light plant here, to cost about $15,000.

MOORESVILLE.—An election was held here recently for the issuance of $10,000 in bonds for the establishment of an electric light plant. The measure carried by a majority of 35 votes. This was the third time an election has been held for bonds for this purpose, but before water works and graded schools were coupled to the light proposition.

SALISBURY.—It has been found that the water power at Whitney, near Salisbury, with a dam proposed to develop 25,000 horse-power, will, on account of the larger size of the basin, be capable of developing 50,000 horse-power. It is expected that the company, in which Mr. E. B. C. Hambley, of the Whitney Reduction Company is interested, will have 50,000 electrical horsepower on the market in two years. The contracts have been let for the dynamos, water-wheels, etc., comprising six units of 8,000 horse-power each. It is said that when the first 50,000 horse-power is developed, there will be 50,000 horse-power additional awaiting attention and that this will be developed, making a total capacity of 100,000 horsepower at the company's plant on the Yadkin River.

NORTH DAKOTA.

FARGO.—William and S. Mainland have sold their interest in the Union Light, Heat & Power Company. Paul Doty was elected president and O. G. Barnes secretary of the re-organized concern.

OHIO.

PORT CLINTON.—The Port Clinton Electric Light & Power Company will add a district heating system to its plant.

LOVELAND.—The Loveland Citizens' Electric Company has decided to issue $50,000 bonds, to be used for the extension of the plant.

LIMA.—Notice has been given of the increase of capital stock of the Lima Electric Railway & Light Company from $850,000 to $1,250,000.

DEFIANCE.—At a meeting of the city council a resolution was introduced declaring it necessary to bond the city in the sum of $50,000 for the purpose of erecting and maintaining an electric light and gas plant.

FOSTORIA.—A committee has been appointed by the Board of Trade to look into the matter of establishing a municipal electric light plant. The present electric lighting contract with the city expires in August next.

HAMILTON.—The board of directors of the Hamilton Gas & Electric Light Company has passed a resolution ratifying the expenditure of $250,000 in improvements on the electric light plant and the Otto Coke Works.

OBERLIN.—The Oberlin Gas & Electric Company has been taken out of the receivers' hands and refinanced by J. C. Hill, of Elyria; A. E. Hay, of Oberlin, and others. The company will install a heating plant and will make important improvements to the lighting plant.

GALION.—According to the statement just issued by the service department, the cost of maintaining and operating the street arc lamps of this city by the municipal plant is but $27 a light per year. Much of the actual cost is paid from the earnings of the commercial department of the plant, leaving but a small balance to be paid by the taxpayers.

LOUDONVILLE.—The electric light plant at this place was almost totally destroyed by fire recently. The city will be in darkness for weeks, and the water supply will be cut off, as the plant furnished the power for pumping the water into the reservoir. The plant was owned and operated by the city and was valued at $10,000. The loss is partially covered by insurance.

EAST LIVERPOOL.—The East Liverpool Traction & Light Company has taken over the property of the United Power Company and the East Liverpool & Wellsville Electric Railway Company, according to reports, and Edward McDonnell, of Buffalo, has taken the place of L. W. Healy, principal owner and manager of the companies. The East Liverpool and Rock Springs railway line and the Rock Springs Park are to be taken over later.

DAYTON.—The Dayton Lighting Company has awarded to G. M. Gest, the expert subway contractor of New York and Cincinnati, a contract for the construction of a complete electrical subway system. This plant has recently been acquired by new interests, who are rebuilding and re-equipping the entire plant. The contract given to Mr. Gest is for subway installation for the whole city, covering 20 miles of streets, and involving over one million feet of conduit. The system is to be modern and up-to-date, the amount involved being in the neighborhood of $250,000.

OKLAHOMA TERRITORY.

GEARY.—The Geary Electric Light & Power Company has been incorporated, with a capital of $3,000.

OREGON.

ROSEBURG.—The citizens have voted to issue bonds for an electric light plant and water works.

ASTORIA.—W. W. Whipple is reported to have secured a franchise to construct an electric light and gas plant and telephone system.

BAKER CITY.—The Fremont Power Company, of which John Waterman, John T. Thomson, of Sumpter, Ore., and Walter Fernald are the incorporators (capital, $200,000), will build the Olive Lake power plant near the Red Boy Mine immediately.

PENNSYLVANIA.

MYERSTOWN.—This town is to have electric lights, to be supplied by feed wires run from Lebanon.

ALBION.—The question of constructing water works and an electric light plant is under consideration here.

NEW CASTLE.—W. A. Burney, representing the Davannah Lighting Company, was recently granted a lighting franchise by the city council.

ELLWOOD CITY.—The Ellwood Electric Light Company has completed arrangements by which it will conduct electricity to Zelienople for lighting and power purposes.

BIRDSBORO.—The Birdsboro Electric Light & Power Company will erect a power plant along the Schuylkill road, and secure the power for running its dynamos from the upper level of the canal by turbine water wheels.

YORK CITY.—The announcement of the preparations which have been made recently for the building of a gigantic hydro-electric plant near McCall's Ferry, on the Susquehanna, by the corporation known as the McCall Ferry Water & Power Company, capital $10,000,000, has revived the Conowingo Falls power plant project.

PHILADELPHIA.—The Tremont & Pine Grove Electric Light & Power Company has sold its plant to Philadelphia, Williamsport and Lancaster capitalists for $30,000. The new owners will extend the lighting facilities to Donaldson on the north, and to Pine Grove, south of Tremont. It is also proposed to connect these towns by trolley.

LANCASTER.—The directors of the Edison Electric Illuminating Company and the Lancaster Gas Light & Fuel Company are reported to have awarded to the Providence Engine Company, of Providence, R. I., the contract for enlarging the electric light plant at Engleside, for $165,000; also to the United Gas Company, of Philadelphia, the contract for constructing a new gas plant, for $100,000.

PHILADELPHIA.—The contract for street lighting for the city of Philadelphia during 1906 has been awarded to the Philadelphia Electric Company. The company was the only bidder for the contract, its bid being $1,073,271.55. This is $118,205.25 less than the estimated cost of the work, the calculations being based on the amount expended this year. Electric lighting cost the city $1,135,508 this year, and in 1904 it spent $1,085,055.

BETHLEHEM.—The Bethlehem borough council has entered into a new contract with the Bethlehem Electric Light Company. The borough agrees to pay the light company the sum of twenty-three cents per lamp per night, instead of twenty-seven and one-half cents, as per old contract, and the sum of $18 per annum for each incandescent lamp. The borough agrees to use a minimum of 137 arc lamps. The light company is to accept payment for all arrears of light at the rate of twenty-five and one-quarter cents per lamp per night. The new contract, which calls for $800 worth of free lighting, is to become operative on and after November 1, 1905.

RHODE ISLAND.

NEWPORT.—The council committee on street lighting has been authorized to ask for bids for the erection and installation of a municipal electric lighting plant.

WYOMING.—It is reported that an electric plant is to be built at Wyoming, with a view to supplying electricity for the different business places in the two villages, and possibly for street lighting.

SOUTH CAROLINA.

BAMBERG.—An election will probably soon be held to vote on issuing bonds for water works and an electric light plant; probable cost, $25,000. G. Moye Dickinson, Mayor.

ANDERSON.—Joseph E. Sirrine, of Greenville, has prepared plans for the electric power plant which is to be constructed at Hatton Shoals on Tugalo River, to develop 5,000 horse-power for the Hatton Shoals Company, of which R. S. Ligon, of Anderson, is president.

GAFFNEY.—The fine water power at Gaston Shoals, on Broad River, near Gaffney, it is reported, will soon be developed. It was recently sold to John B. Cleveland, of Spartanburg, S. C., and others by the Gaffney Manufacturing Company. Electrical power for several towns will be available.

TENNESSEE.

MARTIN.—The city officials will put in about $1,300 worth of improvements at the water and light plant here.

CHATTANOOGA.—The Chattanooga & Tennessee River Power Company has been reorganized, with C. E. James, of Chattanooga, president; J. C. Guild, of Chattanooga, chief engineer, and John Bogart, of New York, N. Y., as consulting engineer. The contract, together with the $100,000 bond which has been made between this company and the Government for the building of the lock and dam for the power plant on Tennessee River, it is stated, has been approved by the War Department.

TEXAS.

TEXARKANA.—S. E. Whiteside and G. West have applied for a franchise for an electric light plant.

HUMBLE.—The electric light and power plant was destroyed by fire recently, involving a loss of $10,000.

ORANGE.—The Orange Ice, Light & Water Company has been incorporated, with a capital of $60,000, by Samuel C. Trimble, W. H. Stark and P. B. Curry.

FORT WORTH.—The Consumers' Light & Heating Company, of this city, was recently organized, with George W. Armstrong president and R. C. Armstrong, Jr., secretary.

WICHITA FALLS.—The Wichita Falls Water Works Company has changed its name to the Wichita Falls Water & Light Company, and increased its capital from $50,000 to $75,000.

UTAH.

PROVO.—W. E. Harding, City Recorder, writes that it is proposed to construct water works and an electric light plant, at a cost of $91,000. Engineer, Frank C. Kelsey, Salt Lake City.

SALT LAKE CITY.—The Inter-Mountain Power Company is preparing to build a system of hydro-electric plants near Salt Lake City, with steam auxiliary. The capacity will be 5,000 horse-power. Plans and specifications are in course of preparation by Frank C. Kelsey, Salt Lake City.

COALVILLE.—A power plant of 2,000 horse-power capacity is projected in this city by the Intermountain Electric Company, the plant to be auxiliary to those already in operation in the Cottonwoods. The new plant will furnish electrical energy for practically all the towns in Summit County. The company has a capitalization of $1,500,000.

TOOELE CITY.—The Clark Electric Power Company, of this city, has secured a franchise from the City Council to erect poles for the installment of electric lights at Grantsville. Work has been commenced on the erection of poles from Tooele City, a distance of twelve miles, and it is estimated that Grantsville will be lighted by the first of November.

PROVO.—The Telluride Power Company contemplates the early establishment of a second electric power plant, to be located at a point on the Duchesne. The plan is to provide electrical energy for mining purposes, and also for distribution in Salt Lake, Park City, Mercur, Eureka, Price and Bingham. The company has made application to the State engineer for 61 feet of water in the Duchesne.

OGDEN.—E. W. Wade has been looking into a proposition relative to the construction of a power plant on the river 17 miles out of Blackfoot, Idaho. Christian Just, of Blackfoot, and others are interested in the project. Mr. Wade states that by the construction of a canal about 1,500 feet long a power plant could be established without building a dam and 1,000 horse-power developed. The power could be increased by erecting a dam. The plan is to furnish light and power to Idaho Falls and Blackfoot. The cost of the project is estimated at $100,000.

VERMONT.

MONTPELIER.—The Consolidated Light & Power Company has increased its capital stock from $350,000 to $1,000,000. The increase was voted last May, when the plant changed owners. The Bolton Falls plant of the company is to be doubled next spring. The present capacity is 2,000 horse-power, and water turbines and machinery will be put in to make the output about 4,000 horse-power.

VIRGINIA.

ASHLAND.—The Virginia Light & Power Company, recently incorporated, proposes to furnish a light and power service. No engineer has been appointed yet, and no bids have been asked for.

RICHMOND.—As to the proposed municipal electric light and power plant, the city attorney has been requested to prepare an ordinance for the issue of $500,000 light plant bonds. The plant proposed will have a capacity of 2,000 horse-power.

PETERSBURG.—Judge Waddill, of the United States District Court, having authorized the receivers of the Virginia Passenger & Power Company to expend $41,000 for the completion of the work on the water power plant of the company in Dinwiddie County, near Petersburg, the work has been resumed near the dam and a large force of laborers is employed. The company has already spent about $100,000 on the plant.

WASHINGTON.

CHINOOK.—The Chinook Light, Power & Water Company is reported incorporated, with a capital of $10,000, by Albion L. Gile and others.

CENTRALIA.—The Kilbourne & Clark Company, of Seattle, is reported to have secured the contract for constructing an electric light system for Centralia.

SPOKANE.—The Spokane-Palouse Light & Power Company is reported incorporated, with a capital of $100,000, by W. E. Goodspeed, B. H. Kiser and others.

BRICKLETON.—H. T. Latham, who operates a flour mill here, has secured an option on electric machinery in Portland, Ore., with a view to installing it to furnish commercial lights in this town.

OLYMPIA.—The Pend O'Reille Electric Company, of Spokane, has filed articles of incorporation, with $50,000 capital stock, by J. L. Drumheller, W. G. Malloy, Joseph Scott and D. M. Drumheller.

PORT TOWNSEND.—The City Council is reported to have received an application from W. A. Pfeiffer for a franchise to construct and maintain an electric light and power plant in connection with a gas plant.

BELLINGHAM.—Stone & Webster, of Boston, Mass., are reported to have purchased the Nooksack power plant from the Bellingham Bay Improvement Company, and will probably expend about $200,000 in improvements.

SPOKANE.—The Big Bend Water Power Company has been organized by J. H. Tilsey, John E. Peterson, Reuben Cross and others, to develop 15,000 horse-power about 28 miles down the river. E. Tappan Tannant is the engineer.

TACOMA.—Bids will be received until November 8 by L. W. Roys, city clerk, for constructing a hydro-electric generating plant of not less than 5,000 and not more than 10,000 horse-power, delivered on the low-tension side of the transformer at the distributing station.

SEATTLE.—The demand for light and power for commercial purposes has been so heavy that City Engineer Thomson and Superintendent L. B. Youngs, of the Water and Light Department, will soon make arrangements for increasing the municipal lighting plant by installing another hydro-electric unit at a cost of $15,000. There are now two units with a capacity of about 3,500 horse-power, and with the third one the capacity will be increased to 5,000 horse-power.

TACOMA.—The Nisqually River water rights, right of way, etc., owned by John L. McMurray, of this city, have been transferred to the Thompson Company, the consideration being named as $75,000. The new interests of the company will be known as the Nisqually Power Company, which has been incorporated with a capital stock of $100,000. The company, it is stated, proposes to establish power-houses, electric generating plants and flume line. It secures 1,500 cubic feet of water per second from the stream. Easement for electric transmission lines is also granted. The stream, it is said, can develop fully 5,000 horse-power at the point where the company's power-houses are to be located, and those interested believe that at least 5,000 additional horse-power can be generated.

WEST VIRGINIA.

MARTINSVILLE.—The citizens voted recently to issue $12,000 bonds to complete the electric light and power plant. J. R. Gregory is the city engineer.

WISCONSIN.

OMRO.—The village will change the electric street lighting from arcs to incandescent.

PORT WASHINGTON.—The proposition to issue $75,000 in bonds for water works and electric light plant has been carried.

LITTLE CHUTE.—The village board has granted a franchise to the Kaukauna Electric Company to furnish electric lights.

FOND DU LAC.—At the next meeting of the common council some action will probably be taken on the application of the Independent Light, Heat & Power Company for a franchise granting it the privilege to establish a plant here.

CANADA.

PORT FRANCES, ONT.—The council is considering the installation of an electric light plant.

OSHAWA, ONT.—The Oshawa Light & Power Company has been incorporated, with a capital of $100,000.

VANCOUVER, B. C.—It is reported that the estimated cost of constructing a municipal plant has been placed at $500,000.

MONTREAL, QUE.—A by-law is before the city council requiring that all overhead wires in the city be put underground.

VICTORIA, B. C.—M. Hutchison, city clerk, writes that the improvement to the electric light plant will be made by the Hinton Electric Company for $9,025.

CHATHAM, N. B.—This town is reported to have voted to apply to the Legislature for power to issue $35,000 bonds for the construction of an electric light plant.

TORONTO, ONT.—The city received authority at the last session of the Legislature to expend $40,000 for a new electric light plant on the Island, and the matter is now being undertaken.

WOODSTOCK, ONT.—By a vote of 427 to 165, the by-law to raise $50,000 for improvements and extensions to the electric lighting and water works plants of this city was carried by the property holders.

TORONTO, ONT.—The Georgian Bay Power Company, of Toronto, has engaged H. von Schon, Detroit, Mich., to plan a development of Eugenia Falls on Beaver River, Ont., where a head of about 400 feet will be available.

CURRIES LANDING, MAN.—A syndicate composed of Canadian and American capitalists intends developing the water power on the Assiniboine River at Brandon, Man. The intention is to erect a large power house and plant at this city.

OTTAWA, ONT.—The Dominion government has passed an order granting permission for the construction of a dam across the Rainy River at Fort Francis. This proposal has been before the government for a long time, and electrical interests have been urging for the power to make the improvement.

WESTMOUNT, QUE.—The Robb Engine Company is reported to have secured the contract for the engines, accessories and their erection in connection with the new electric light plant for $8,300. The Custodis Chimney Construction Company secured the contract for building the chimney for the plant at $6,250.

ST. CATHARINES, ONT.—The council has passed a by-law granting the Cataract Power Company a 25-year franchise, for which the city gets, free of cost, 215 incandescent lights of 16-candle-power capacity, which is estimated to be worth $1,000 a year. In addition the company is to erect a generating station at Decaw Falls. This will make the cash value of the extensions about $150,000. The Toronto & Niagara Power Company has also applied for a similar franchise to that granted the Cataract Power Company, which was also carried, but held over, and not to come into force until the company has handed over to the city a lease of its hydraulic canal for water works purposes.

WINNIPEG, MAN.—The development of electric current from a water power at Lac du Bonnet on the Pinnewa channel of the Winnipeg River, about 30 miles from here, is rapidly approaching completion. At the present time over 1,000 men are employed. The power house is completed and is almost sufficient for the transmission of 10,000 horse-power. The rock excavations in the channel are also about completed. Already no less than 75,000 cubic yards of rock have been moved. This will provide sufficient water for the ultimate development of 30,000 horse-power, which will supply power to the street railway for running its cars, the balance being used for power and light for the city, and also power for the manufacturers.

OTTAWA, ONT.—The Ottawa Electric Company, in order to prevent all possibility of impaired service owing to the carrying out of works of improvement, shortage of water, anchor ice, etc., has decided to install a steam reserve plant of considerable capacity, in addition to the steam plant already owned and operated by this company as an emergency plant. The new installation will consist of a Westinghouse-Parsons steam turbine direct-connected to a 2-phase 1,500-kw. alternating-current generator. The exciter will be mounted on a bracket and on the turbine frame, and direct-connected to the turbine shaft, and there will be other sources of current for exciting the field, which will be available at any time in case of failure of the exciter. The boiler capacity will be sufficient to operate the turbine and generator to the highest limit allowable for overload when desired.

TORONTO, ONT.—Frederic Nicholls, general manager of the Canadian General Electric Company, and also a director of the Electrical Development Company, states that all the plans are about completed for the extension of the power-transmission lines through the western peninsula of Ontario, from Niagara Falls. London is the objective point from the Falls for the present. Plans are complete and surveys will be made at once, going through Brantford, Paris, Galt, Guelph, Berlin, Hespeler, Woodstock, Ingersoll and the smaller towns, and supplying electric power to all the electric railways for operating purposes. The power house at Niagara will be completed sooner than was expected, as the steel frame for this is now being erected. The overhead work from Niagara has been completed, with the exception of a few intersections, where legal formalities have to be complied with. Power is promised for Toronto within three months, but not enough at first to run all the street cars.

MONTREAL, QUE. — The equipment of the power plant of the Kaministiquia Power Company, now being erected at Kakabeka Falls, near Fort William, Ont., will be the best that can be secured. A part of it has been contracted for in Germany, while the motors, transformers and other equipment will be supplied by the Canadian General Electric Company. The actual water head is 181 feet high, which is considerably higher than at Niagara Falls. It is the intention of the company to generate 30,000 horse-power, the first installation on which work is now being rushed, being 10,000 horse-power. The company expects to deliver power into Fort William about June 1 next, and the indications are that the entire amount of power that will be available will be readily disposed of. In addition to contracts with the Ogilvie Flour Mills Company, which will take 1,000 horse-power, and the town of Fort William, power will be sold to the Canadian Pacific and Grand Trunk railways. A large American industrial company will also take power from the company.

MEXICO.

LA BARCA.—Francisco Castellanos proposes to establish an electric light and power plant at La Barca.

VERA CRUZ.—An electric power plant will be installed on the Laguna de Catemaco, State of Vera Cruz, by Juan Simon Rodriguez.

CITY OF MEXICO.—Ignacio Saldana will install a large electric power plant on the Rio del Salto. He has made application to the federal government for a concession.

CULIACAN.—Diego Redo will install an electric power plant on the Tamazula River, in the State of Sinaloa. The power will be transmitted to industries and towns of that section.

CITY OF MEXICO.—Vicente Martinez, of the City of Mexico, will build an electric plant for the transmission of electric power at Xicotlacotia between the states of Morelos and Guerrero.

CITY OF MEXICO.—Luis E. Reyes, of the City of Mexico, will establish an electric power plant in the State of San Luis Potosi, at a waterfall on the Los Naranjos River. The electric power will be transmitted a considerable distance.

CORDOVA.—George G. Bergman, of the City of Mexico, has applied to the federal government for a concession to install a large electric power plant on the Blanco River, near Cordova. The electric current will be transmitted to towns and industrial centers in that region.

GUADALAJARA. — Compania Industrial de Guadalajara, which operates two electric power plants situated on the Santiago River, near Guadalajara, will compete with La Electra Company for business of furnishing electric lights and power in Guadalajara. It is stated that its plants will be enlarged and other extensive improvements made.

MERIDA.—The Merida Electric Light Company and the city council are involved in a dispute over the delay by the company in placing its wires underground. The council has informed the company that if it does not fulfill its obligations in the matter within six months the council will proceed to bury the wires and charge the work to the company. Furthermore, the company will be fined for its delay.

SAN IGNACIO.—Jose H. Rico, president of the Guadalupe de los Reyes Mining Company, has made application to the federal government for a concession to install and operate an electric light and power plant near this city. The company which he represents will erect a dam at the juncture of the Plaxtla and Arroyo rivers and obtain water power for operating the electric plant from that source. The power will be transmitted to towns of that section, and will also be used for operating the machinery of the mines of the Guadalupe de los Reyes Mining Company.

American Electrician.

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ELECTRIC TRANSMISSION AND DISTRIBUTION IN VERMONT.

HYDRO-ELECTRIC GENERATING STATION AND SUB-STATIONS OF THE CHITTENDEN POWER COMPANY AT RUTLAND.

The Chittenden Power Company is about to place in operation its new power plant located about five miles from the City of Rutland, Vermont, one sub-station in the City of Rutland, and one sub-station at Castleton Corners, about 15 miles distant from Rutland, in a direction opposite from the power plant. The system will supply the Rutland Street Railway Company with power to operate the city railway line in Rutland, and an interurban road from West Rutland and Castleton to Fairhaven. Power is at present supplied from a steam generating plant located about midway between Rutland and Fairhaven. The situation of this plant is such as to necessitate considerable hauling of coal and other supplies, which with the present price of coal at Rutland undoubtedly means high generating cost. The building of the new plant was started last fall and it is just now receiving the finishing touches.

A reservoir is located above Rutland among the hills and an extensive dam with head-gates and spillway has been constructed at that point for retaining sufficient water supply to maintain continuous plant operation throughout the year.

Immediately above the reservoir which supplies the present plant is located a much larger reservoir, which can be developed later, and which will undoubtedly produce a greater quantity of power than the new plant does at present.

From the upper reservoir to the present reservoir, a 400-ft. head can be utilized. From the lower reservoir a pipe line 5 feet in diameter and 5000 feet in length, is carried down the valley to the new power plant, giving to this plant a head of somewhat over 200 feet. The 5-ft. pipe line is constructed of steel plate throughout, lap welded and double-riveted in all seams towards the latter end of the run, and lap-welded with a single row of rivets at the head of the run. Considerable excavation was necessary in order to properly install this pipe line, as the low temperature prevailing in this country during the winter months made it imperative that the complete line should be covered up.

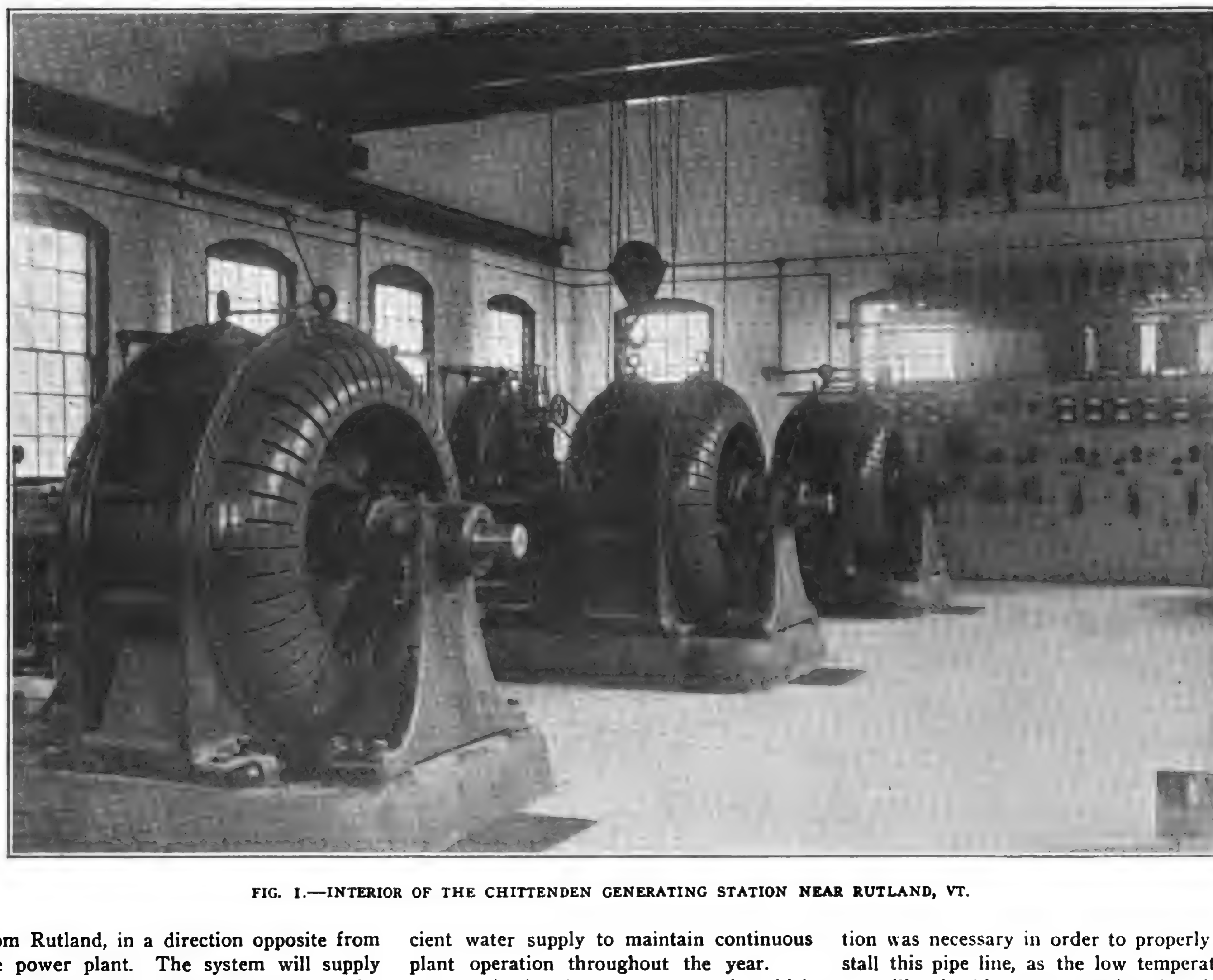

FIG. I.—INTERIOR OF THE CHITTENDEN GENERATING STATION NEAR RUTLAND, VT.

The power station is a brick structure with steel trusses and concrete slab roof. There are no purlines in the roof construction, as the slabs for the roof were

moulded in forms set up on the ground, and after hardening were transported to the site of the power house—a distance of about 300 feet; removed from the forms; hoisted to the roof and properly attached to the steel trusses. After being leveled the joints were pointed up with neat cement and a finished roof covering of roofing felt and an asphaltic compound installed. These slabs are 4 feet wide, 8 feet 6 inches in length, 3½ inches in thickness, reinforced with 3 inches No. 10 expanded metal, and are composed of one part cement, 2 parts coarse, sharp sand and three parts clear, crushed stone, or gravel. Considerable gravel was used in the concrete work for foundations, floors and roofing for this building, as gravel was readily obtainable from the beds of two creeks which flowed one on each side of the power house. The sand for construction purposes was also conveniently located as a bank was found close to the power house site and on top of the hill. In order to utilize this sand it was only neces-

FIG. 2.—PIPE LINE.

FIG. 3.—VIEW OF POWER HOUSE SHOWING WATER TOWER.

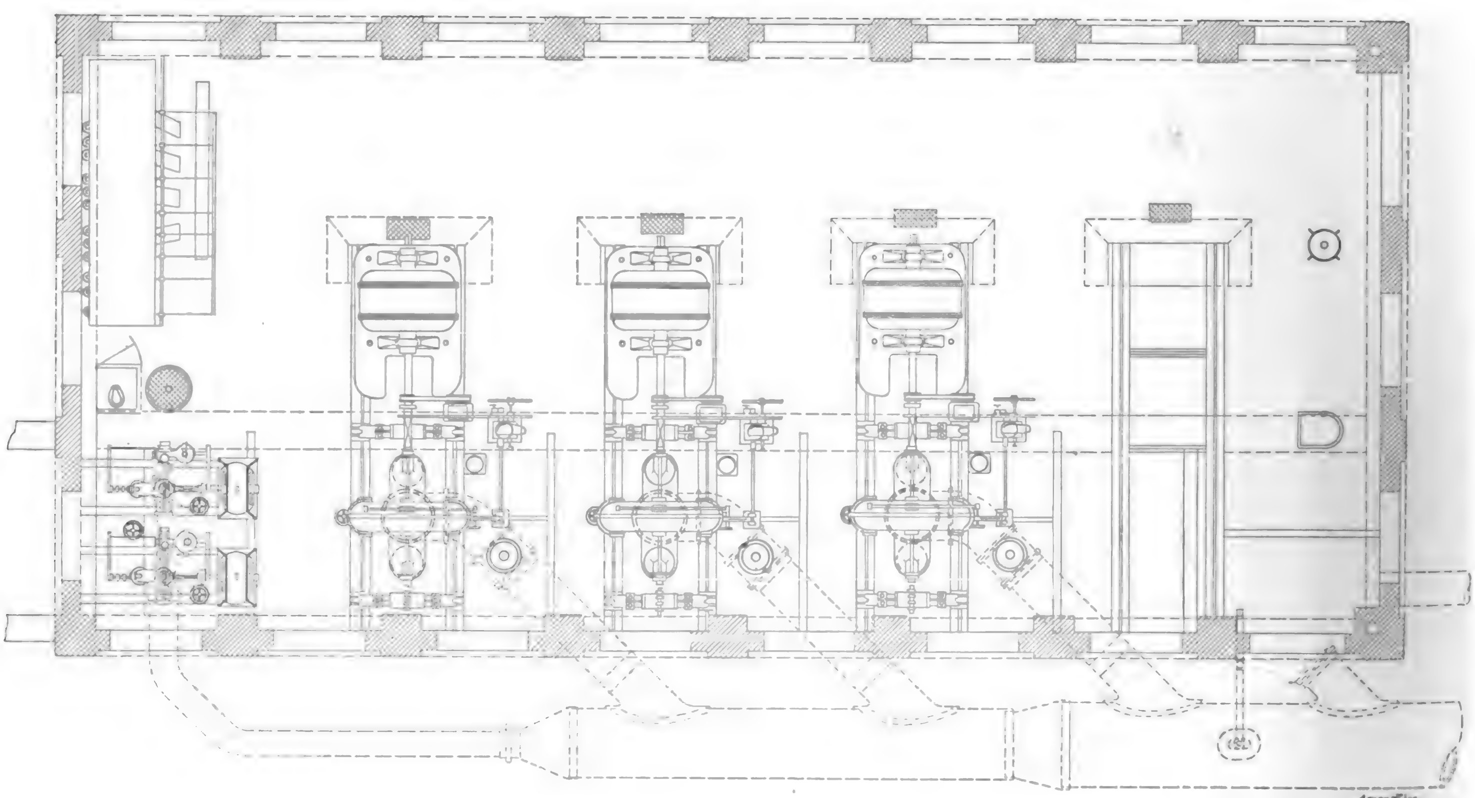

FIG. 3.—PLAN VIEW OF MAIN STATION.

sary to install a sheet-iron chute which deposited the sand at the proper location.

The pipe line is carried along the side of the building, and branches are taken in to four turbine wheels. A smaller branch is also taken in to supply two exciter wheels. Any of these branches can readily be cut out by gate-valves, which are installed on the branches close to where these enter the building. Pressure in this pipe line is maintained constant, and pounding or water hammering eliminated by the installation of a regulating tower 220 feet high having a tank of sufficient capacity to relieve the wheels of fluctuations in pressure in the pipe line.

The tank referred to is 16 feet in diameter and 50 feet high. It is built of bent steel plates properly riveted together, with a hemispherical bottom, also constructed of heavy steel plates properly riveted. A frost-proofing of wood encases the steel tank. The space between the frost-proofing and the steel tank is supplied with heat by a steam pipe running from a heater located in the power house to prevent freezing of water in the winter time.

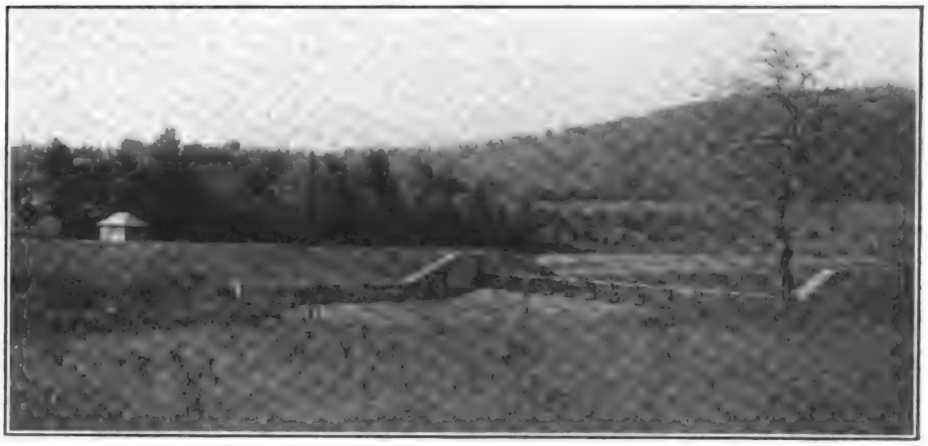

FIG. 5.—HEADGATE AND SPILLWAY.

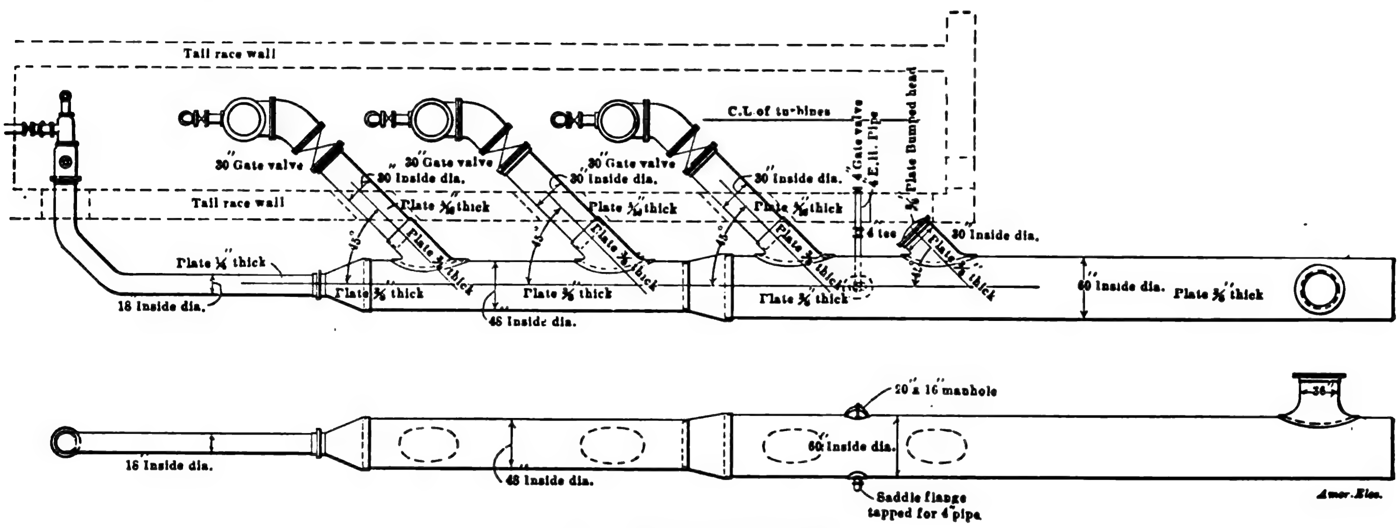

FIG. 4.—DETAIL OF PENSTOCK.

The tank is supported on four lateral channel legs with sufficient struts and diagonal bracing to make a very stiff structure. Access to the tank from the ground is obtained by climbing the lateral braces on one of the columns. A circular platform surrounds the bottom portion of the tank.

The run of the penstock is directly below and in line with the overhead tower. An 18-inch riser pipe supplies the tower with water. This pipe is encased within a 36-inch overflow pipe, which takes care of the

FIG. 6.—TRANSMISSION LINES.

FIG. 7.—REAR VIEW OF STATION SHOWING TAIL RACE.

fluctuations of the water lever, when suddenly shutting off or starting up the wheel.

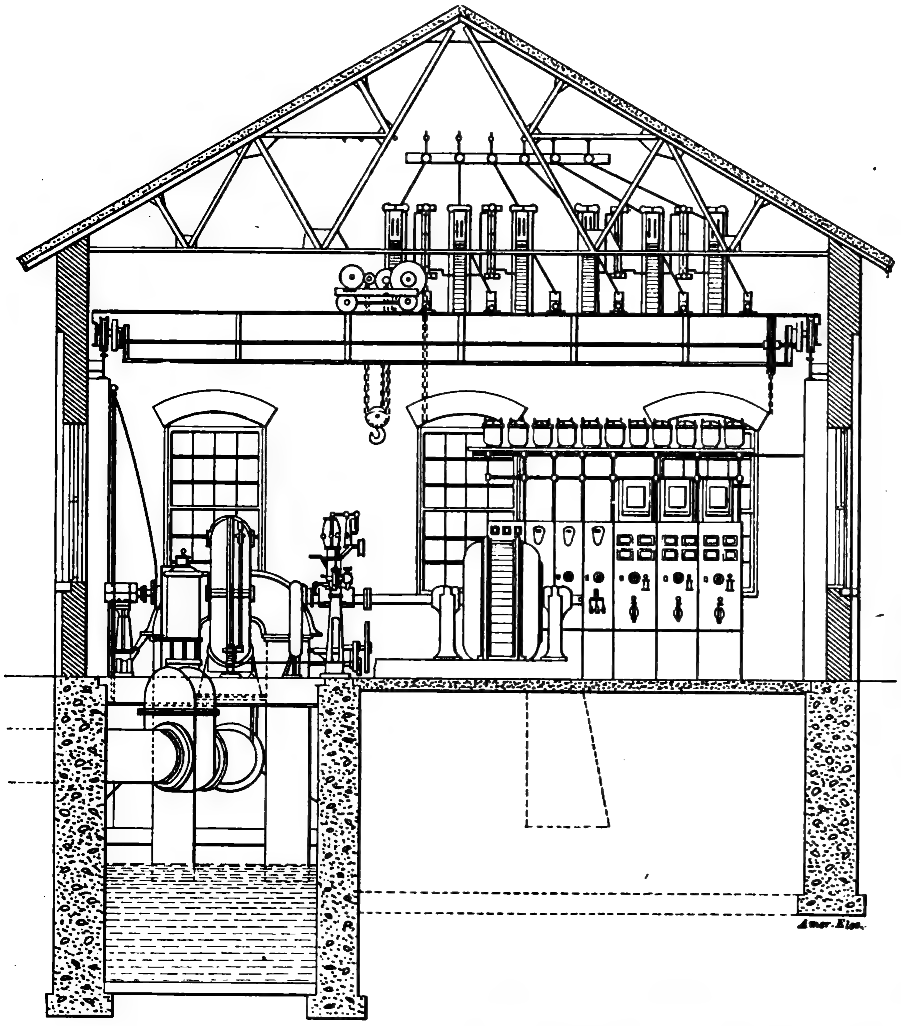

FIG. 8.—SECTIONAL ELEVATION OF MAIN STATION.

The space between the supply pipe and the overflow pipe is heated from the same system which heats the space between the steel tank and the frost-proofing.

The tail race is located immediately under the wheels and is carried about 150 feet beyond the power house, where it empties into the waste stream from the reservoir. It has concrete sides and bottom, and has a Weir plate installed outside of the power house for the purposes of measuring the water used.

The power house at the present time contains three 400-kw. revolving-field, alternating-current generators, with provision for the installation of a fourth unit. These are directly connected to three double discharge water wheels, which develop 770 horse-power at full gate opening. The wheels are enclosed in cast iron, manholes being provided for easy access to all parts, and supplied with 30-inch diameter supply pipe set to receive water from below. A 30-inch hydraulic valve controls the water supply to the wheels. All wheels are independently governed by Lombard type "F" governors. The generators are designed to run at 500 r.p.m., and to develop an e.m.f. of 13,200 volts.

Two exciters of approximately 25 kilowatts capacity are installed, and driven by small water turbines under the same pressure as the large wheels. Indicating devices for recording pressures and head of tail water, etc., are installed, and an indicating and recording tachometer is provided for each wheel; in fact, no pains have been spared to provide a hydraulic equipment which will be permanent, and insure satisfactory and continuous operation, under the varying conditions of load which are naturally met with in a railway installation.

FIG. 9.—TURBINE-DRIVEN EXCITER UNITS.

The switchboard to control this installation consists of panels for controlling the exciters, independent generator panels for each of the generating units, a regulating panel complete with automatic regulator for keeping the pressure constant at the delivery end of the transmission line, and two three-phase line panels. The generator and line panels are provided with high-tension oil switches mounted in concrete cell compartments and are hand-operated from the face of the switchboard.

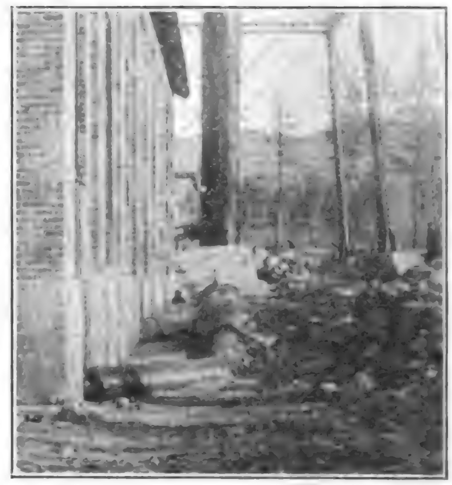

FIG. 10.—PENSTOCK.

All wiring for power in the building is encased in lead-covered cables, and has a working capacity of twice that under which it will operate. The power house lighting wiring is entirely encased in iron conduit, incandescent lamps being used throughout.

To facilitate the dismantling and repairing of machinery, the building is provided with a hand-operated overhead crane, and every means has been taken to insure easy operation and comfort to the operators.

From the power plant two three-phase, 13,200-volt transmission lines are carried in an air line mostly on private right of way, to the Rutland sub-station, located near the center of the City of Rutland, and from this sub-station one three-phase transmission line is carried to the Castleton sub-station, located on the main street of Castleton Corners.

These transmission lines are protected by lightning arresters, located within the buildings at each of the stations, and are so provided with high-tension switching apparatus, that either of the two transmission lines from the power house to the Rutland sub-station, can be used, or the two can be thrown in parallel. The switching apparatus in the Rutland sub-station has been installed so that the Castleton sub-station can be operated on either of the lines from Rutland to the power house, or can be disconnected from the main line and can be operated on the same lines with the Rutland sub-station, thus allowing entire flexibility of the transmission system, and eliminating all possible danger from interruption.

The Rutland sub-station is a brick structure with a concrete roof, this roof being built in place. The building is located on property controlled by the Chittenden

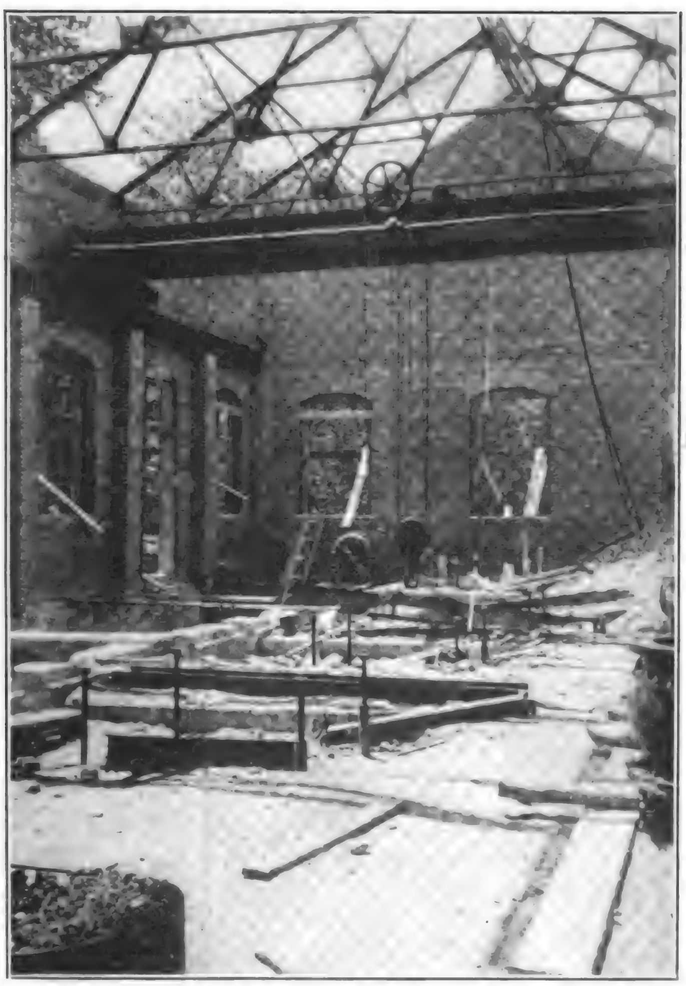

FIG. 11.—MAIN STATION IN COURSE OF ERECTION.

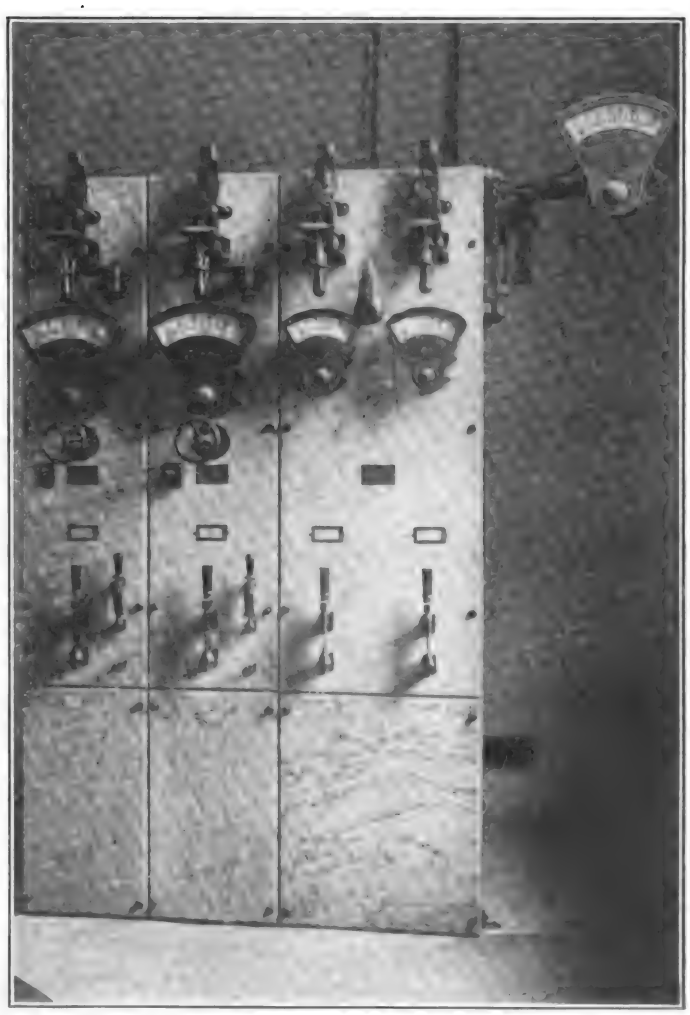

FIG. 13.—SUB-STATION SWITCHBOARD.

Power Company, and located in the vicinity of the company's gas works. The building is of adequate size to contain the present apparatus, and later addition of one unit making a total of three 150-kw. rotary converters. One side of the interior wall

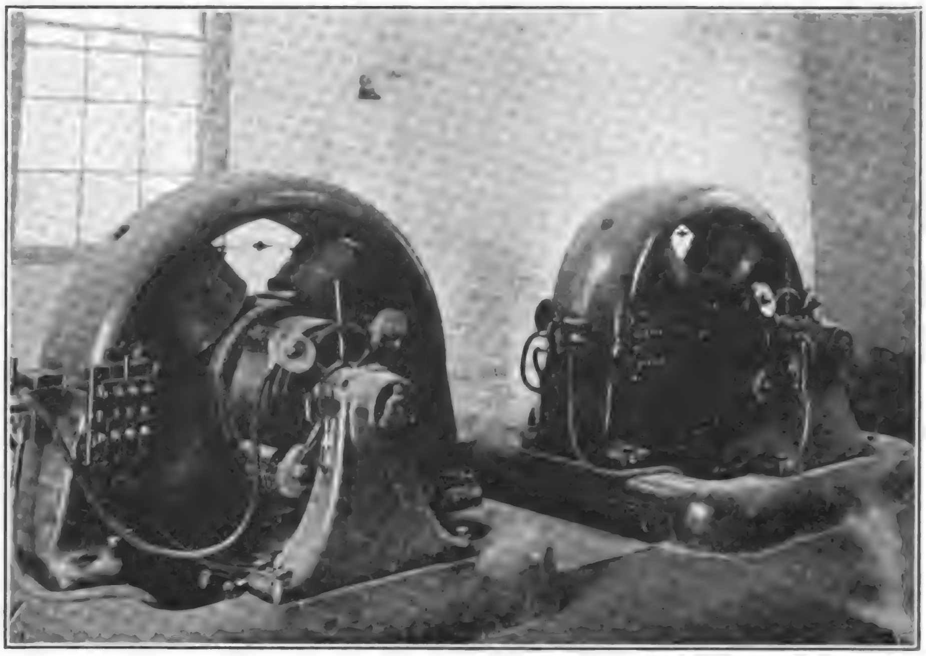

FIG. 12.—ROTARY CONVERTERS IN SUB-STATION.

is devoted to high-tension switching apparatus and lightning arresters, in accordance with the above-described installation.

It is calculated that the transmission pressure at the entrance to this sub-station will be about 12,500 volts, which pressure is carried through high-tension oil switches, mounted in brick compartments, and thence to three 125-kw. air blast transformers connected in delta on the high-tension side. The low-tension side of these transformers is provided with double windings and connected in double delta, the secondary e.m.f. being 370 volts. These transformers are

air-cooled and all wiring and connections on the low-tension side are in the air pits under the transformers.

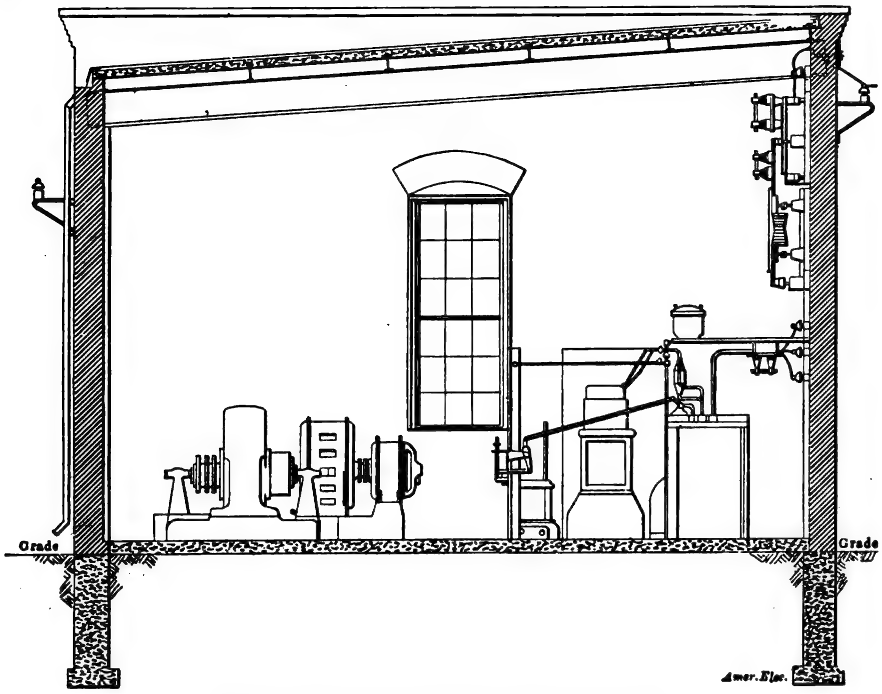

FIG. 14.—SECTIONAL ELEVATION OF SUB-STATION.

The reactance coils are also air-cooled and are equipped with the necessary switching apparatus, for starting the rotary converters from the half voltage taps of the transformers, thus reducing the power consumption at the time of starting the rotaries, and allowing better regulation throughout the system.

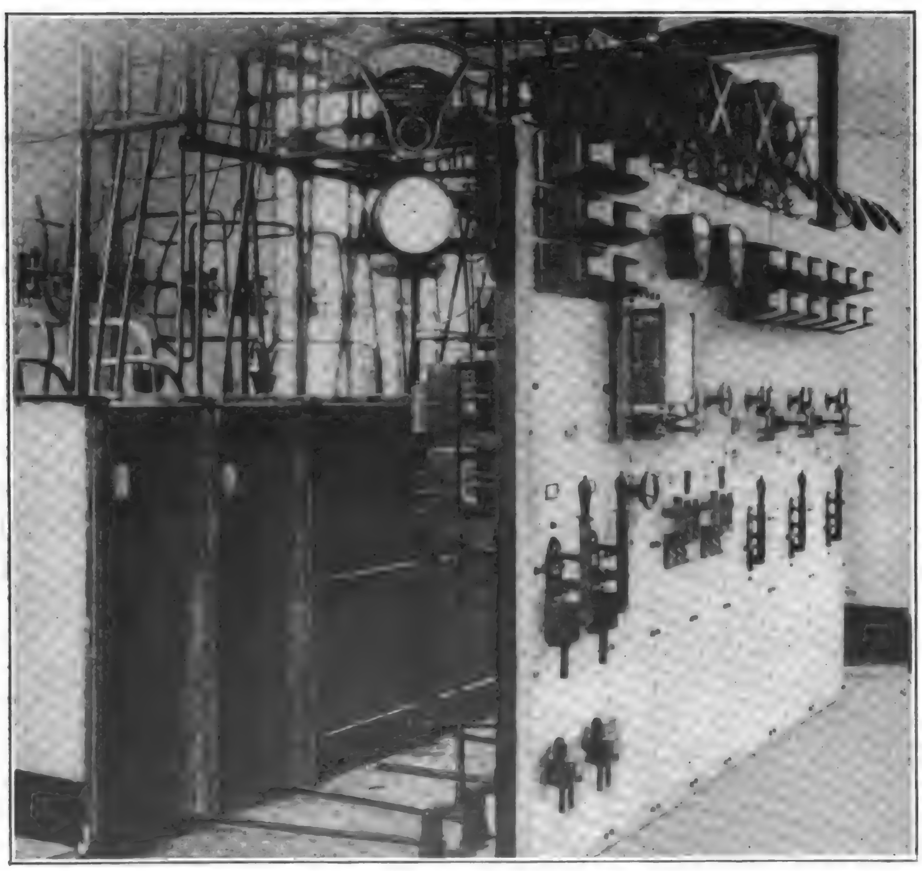

FIG. 15.—SWITCHBOARD IN MAIN STATION.

The low-tension wiring in these sub-stations, as in the case of the power house, is lead-covered, but paper insulation has been substituted in the sub-station in place of the rubber insulation used in the main power house. All open, high-pressure wiring in the stations is rubber-covered. The high-tension oil switches are hand-operated, from the high-tension line panel, which is also equipped with the necessary high-tension instruments.

This sub-station, as before stated, contains at the present time two 150-kw. rotary converters, which converters are installed over the wiring pits. All wires and cables are carried from one piece of apparatus to another in camp conduit, laid in the floor of the buildings.

The rotary converters are each provided with a direct-current rotary panel and an additional line feeder panel for controlling the various railway feeders. This panel is equipped with the necessary indicating and recording instruments and lightning arresters.

The transformers have duplicate blower sets, each of sufficient capacity to supply requirements, and each of these blower sets has its operating panel.

The Castleton sub-station building and equipment are the same in all general details as those of the Rutland sub-station, with the exception that the rotaries and their accessory apparatus are of different sizes, there being installed at the present time one 150-kw and one 200-kw. rotary converter, with adequate space for a future installation when conditions require it, of a further 200-kw. rotary converter.

The design of the entire system is such as to insure continuous and satisfactory operation under the worst conditions of load which are imposed by a railway system operating a city and interurban service. J. G. White & Co., of New York City, were the general contractors for the entire equipment and French & Bryant, of Boston, Mass., were the engineers for the Chittenden Power Company. The complete penstock work from the dam to the regulating tower and all the transmission lines were designed and installed by this latter firm.

STEAM ENGINE LUBRICATION.

BY R. T. STROHM.

Next in importance to a good lubricant is a proper device for feeding that lubricant to the bearings. No matter how excellent the lubricant, nor how painstaking the engineer in selecting it, there will be trouble if the lubricator fails to supply the bearing regularly and continuously with the necessary amount of lubricant. It is the purpose of the succeeding paragraphs to describe the construction and operation of various lubricators as applied to the steam engine, with the exception of those used in cylinder lubrication.

The crosshead guides are usually oiled by means of stationary sight-feed oil cups, which may be placed directly on the frame, or upon the guides. In case the guides consist of four rectangular bars, it is common to screw the oil cup into the upper guide bar on each side. The oil passes down through a hole in the guide and is distributed by the movement of the crosshead.

Most horizontal stationary engines are built so as to run over. That is, the crankpin passes over the shaft while the engine is making its forward stroke. Under these conditions there is little pressure on the upper guide, the greater portion of the pressure and the wear coming on the lower guide. Consequently, positive means should

be used to lubricate properly the lower slide. That is, the oil should be carried to the guide and there distributed, instead of chance drops being allowed to fall thereon.

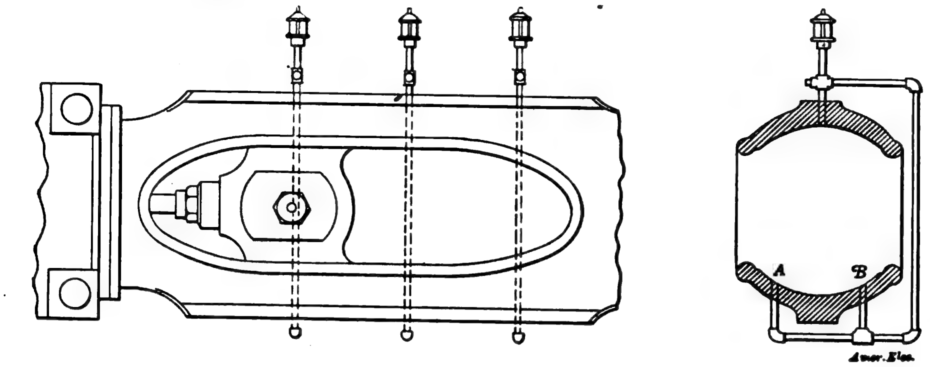

FIG. 1.

One method of securing positive lubrication of the guides of a Corliss engine is shown in Fig. 1. Three oil cups are used for the lower guide, one located near the mid travel point of the cross-head, and the others near the extreme points of travel, while a single cup attached to the frame at the mid-stroke position suffices for the upper slide on which the pressure is slight. The pipes leading from the cups to the lower guide are branched and each is tapped into the lower guide bar at two points, *A* and *B*, thus insuring good lubrication. To assist still further the distribution of the oil along the surface of the guides, the cross-head shoes are frequently grooved, these grooves serving to carry the oil to all parts of the bearing surfaces.

On vertical engines oil pipes may be tapped into the guides, at both sides, near the top, and the oil cups placed on these. It is not uncommon, however, to find an additional arrangement for lubricating the guides. To the bottom edge of each cross-head shoe is sometimes attached a piece of sheet brass or copper which is bent so as to fit flat against the surface of the guide. The lower edge of this sheet is cut into saw-tooth form, and at the end of the downward stroke these saw-teeth dip into an oil reservoir attached to the guide. On the upward stroke the oil picked up from the reservoir by these teeth is distributed over the surfaces of the guides.

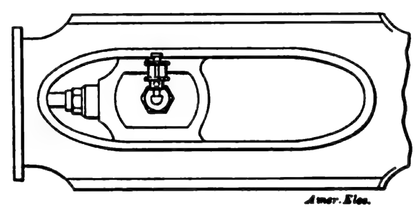

FIG. 3.

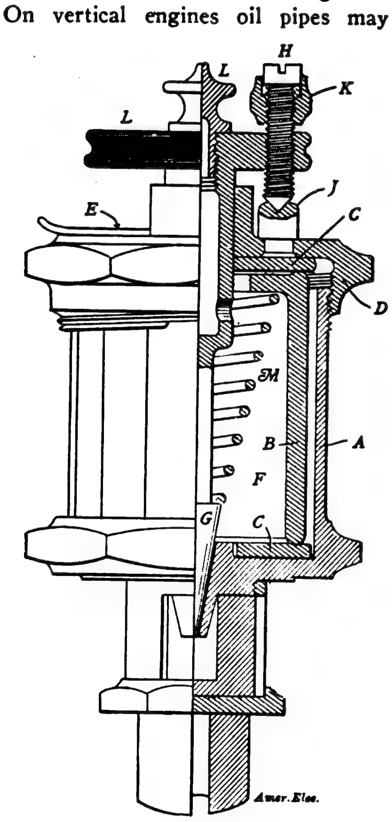

FIG. 2.

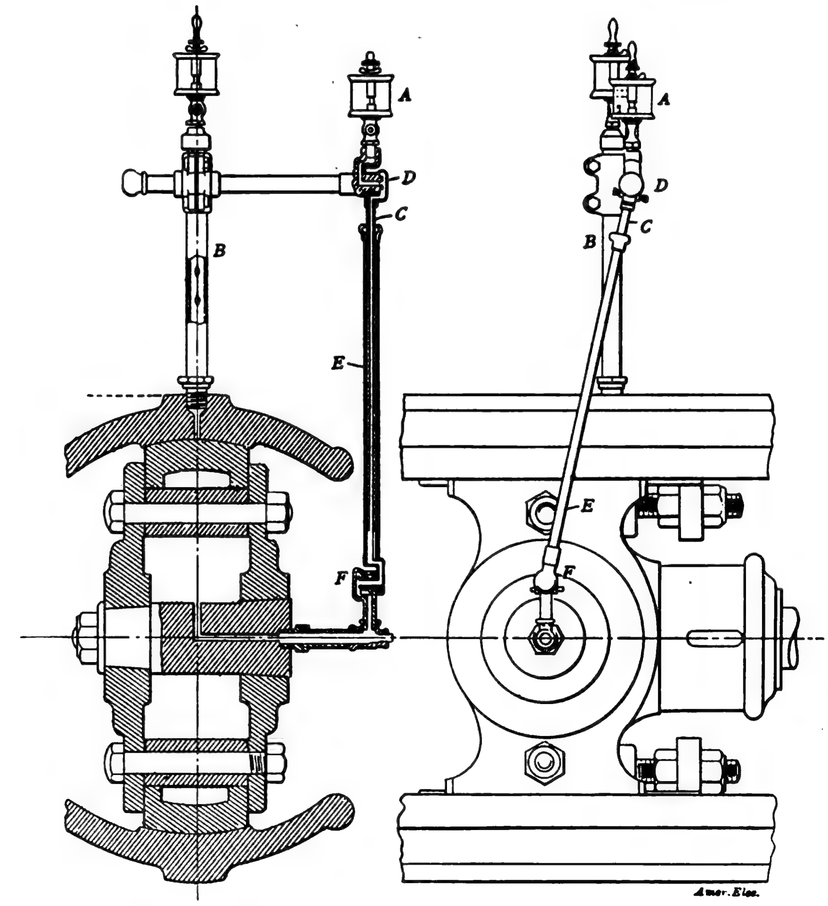

FIG. 4.

The construction of an oil cup should be such as to permit a regular and definite rate of feed for oils of varying viscosity, in order that the rate of supply of oil to a bearing may be found by trial adjustments and thereafter fixed. A form of cup embodying these features is shown partially in section and partially in elevation, by Fig. 2. The body of the cup, *A*, is of brass, enclosing a glass case, *B*, which rests upon cork washers, *C C*, at top and bottom. The glass case is firmly held between these washers by screwing down the brass cap, *D*. There is a hole beneath the slide, *E*, through which oil is poured into the oil chamber, *F*, of the cup. The slide prevents dirt and dust from finding its way into the oil chamber when the cup is in service. The oil is fed to the bearing through a hole in the bottom of the cup. The rate of flow is regulated by a conical valve, *G*, the position of which may be altered by the set-screw, *H*, at the top. When the cup is in use the set-screw bears upon a nipple, *J*, fastened to the cover of the cup. By turning the set-screw the valve, *G*, may be raised or lowered until the proper rate of feed is obtained. Then the thumb-nut, *K*, is tightened. When no oil is needed the wheel, *L*, is lifted and at the same time rotated slightly. This takes the set-screw, *H*, off the nipple, *J*, and the spring, *M*, then forces the valve, *G*, tightly on its seat. When the engine starts again the wheel, *L*, is lifted and the screw, *H*, is again returned to the nipple, *J*, when the cup will resume feeding at the same rate as before.

A simple method of oiling the cross-head pin is illustrated in Fig. 3. An oil cup is attached to a short ell of pipe which is screwed into the pin, a hole along the axis of the pin serving to convey the oil to the surface of the pin. This is a very con-

venient method where the engine runs for a portion of the day and is shut down over night. The periodical stopping permits the oil cup to be refilled, when necessary.

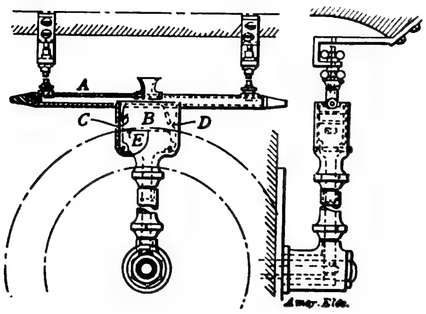

FIG. 5.

But where an engine is used on long, continuous runs, a wholly different method must be pursued. It is impracticable to fill a cup, attached as in Fig. 3, while the engine is in motion, and it would require an absurdly large cup to hold sufficient oil for a long run. Hence, the telescopic oiler, as shown in Fig. 4, has been produced.

The oil cup, *A*, is fixed by a horizontal arm to a rigid standard, *B*. The oil, upon leaving the cup, passes downward into the small pipe, *C*, by way of the spring joint, *D*. The small pipe, *C*, is enclosed by a larger one, *E*, which is in turn connected to another swing joint, *F*, at its lower end. The latter joint conducts the oil from the pipe, *E*, to the oil channel through the pin. The operation of the device is very simple. As the cross-head moves back and forth, the pipe, *C*, slides into and out of the pipe, *E*, the oil being thus conducted directly to the pin without wasting. This form of lubricator can be applied to vertical engines also, and to the lubrication of crank-pins and eccentrics, as well.

Another common method of oiling cross-

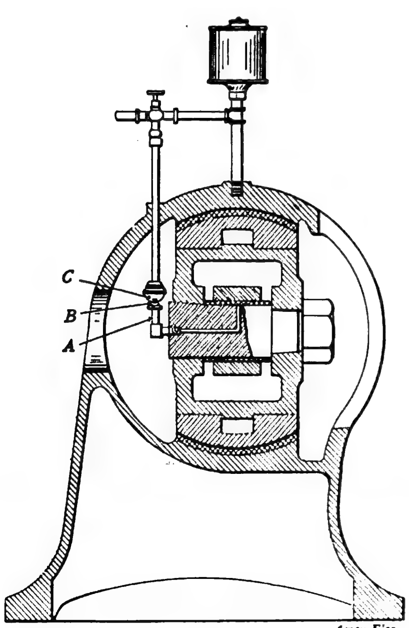

FIG. 6.

head pins is by the use of wipers. A device of this kind is illustrated in Fig. 5. A stationary oil cup, fastened to the engine frame, supplies oil to a horizontal tube, *A*, closed at the ends and perforated along the upper side by a number of holes. This tube is also held rigidly in place by connections to the frame. The wiper cup, *B*, is attached to the cross-head, and contains two wipers, *C* and *D*, pivoted at their lower ends and held together by a link, *E*, thus permitting them to move in unison on their pivots. They are so located in relation to each other that when the wiper, *C*, is vertical against the end of the cup, it just misses the lower edge of the tube, *A*, and wipes off the drops of oil which hang from the bottom of the tube. The other wiper, *D*, in the meanwhile is slanting and does not touch the tube, *A*. On reaching the end of the stroke towards the right, however, the inertia of the wipers throws them to the right so that *D* comes into a vertical position and *C* assumes a slanting posi-

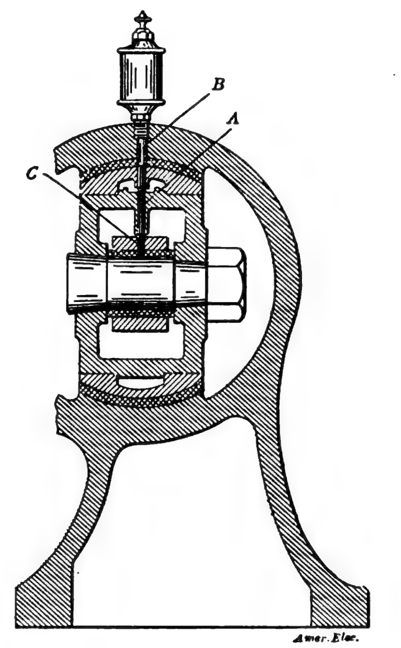

FIG. 7.

tion, the former wiping the drops from the tube, *A*, on the stroke toward the left. The oil thus collected in the wiper cup, *B*, is conveyed, by an oil hole in the pin, to the bearing surfaces. The tube, *A*, is capable of vertical adjustment, so that it can be raised or lowered to keep the edges of the wipers at the proper distance.

A different form of wiper is illustrated in Fig. 6. In this case the wiper cup, *A*, contains a single rigid wiper, *B*, which, at each stroke of the engine, passes under and touches the lower end of the oil pipe, *C*, which is fitted with a rounded cap, slotted in the center. The oil is then conveyed to the pin in the usual manner. This form of oiler is objected to by some engineers, especially by men running high-speed engines, for the reason that the rapid motion of the cross-head at mid-stroke, when the wiper is just touching the end of the pipe, tends to scatter or splash the oil all over the frame, floor and surrounding objects, which not only deprives the pin of lubricant, but also wastes the oil and spoils the appearance of the engine room. This action may be obviated by placing the pipe, *C*, very near the end of the stroke of the cross-head pin, since at that point the cross-head will have considerably less velocity than at mid-stroke.

In Fig. 7 is illustrated a method of oiling the cross-head pin in which neither a wiper nor a telescoping pipe is used. A hole, *A*, is drilled through the upper shoe of the

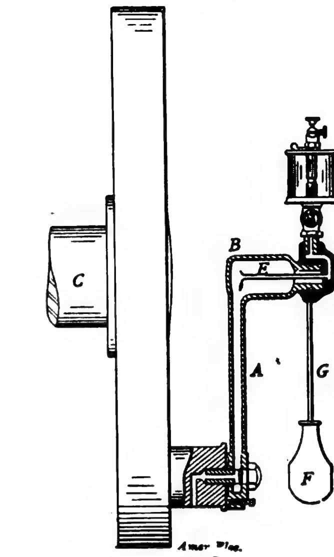

FIG. 8.

cross-head and cross-head frame, being so located that as the cross-head moves back and forth this hole matches with the hole, *B*, through the guide, by way of which the oil is supplied. Oil thus finds its way down through the channel, A, and drops into an oil hole, *C*, in the connecting-rod strap, by which it is led to the pin. This method, while not so positive as the others, has nevertheless given satisfactory results, particularly on the smaller engines.

The crank-pin may also be oiled in a number of different ways. The most common, perhaps, is the plain oil cup screwed into the connecting-rod strap and delivering oil to the pin through a hole in the strap. This method, however, is not applicable in cases where it is necessary to keep the engine in motion for long periods, without any stops, since the cup could not hold enough lubricant to supply the pin for the required time.

A solution of this difficulty lies in the use of a crank-pin oiler like that illustrated in Fig. 8. A hollow arm, *A*, is bolted rigidly to the crank-pin, the hole through the arm being connected with the oil hole in the pin, as shown. The end, *B*, of this arm is di-

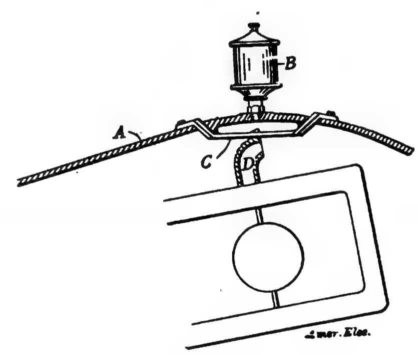

FIG. 9.

rectly on a line with the axis of the shaft, *C*, so that as the crank disc turns the arm, *A*, turns with it, the end, *B*, simply rotating without any lateral motion. The free end of the arm, *A*, has a journal formed upon

it, on which is placed the oil cup holder, *D*, the oil passing through a duct in the holder, to the pipe, *E*, and thence to the hollow arm, *A*. A weight, *F*, is suspended by a stiff rod, *G*, from the cup holder, and this weight serves to keep the cup always in an upright position. The oil which drips from the pipe, *E*, into the hollow arm is thrown outward by the centrifugal force and thus fed to the pin. By this device, every drop of oil that leaves the cup must eventually reach the crank-pin, so that waste and scattering of oil are avoided. An oiler of similar construction has the cup fastened to a stand which is bolted to the bed-plate of the engine. Both of these types are largely used at the present time on both horizontal and vertical engines.

On center-crank engines, however, it is impossible to use this scheme, unless an oil hole be drilled along the axis of the crank-shaft and along one arm of the crank to the pin. This is a difficult matter in case the shaft is long and the crank near the middle. A telescopic oiler, however, might be used, as described in connection with cross-head pin oiling.

Fig. 9 shows still another method. The crank is enclosed in a metallic casing, *A*,

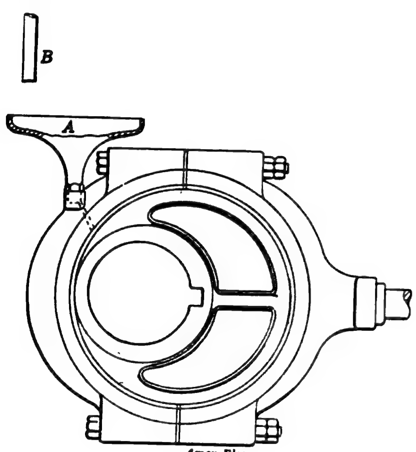

FIG. 10.

at the highest point of which the sight-feed oil cup, *B*, is placed. The oil from the cup drops upon a piece of wick, *G*, held by clamps on the inner surface of the casing. A hollow metallic wiper, *D*, is attached to the connecting-rod strap, and at each revolution the wiper touches the wick, taking off the drops of oil that gather on the under surface of the wick, and then, by oil channels, the lubricant is conveyed to the crank-pin. The casing, *A*, avoids the spattering of oil over the engine.

In some high-speed engines the lubrication of the crank-pin and of the cross-head guides is accomplished by splashing the oil upon them. To this end, the crank, connecting-rod and cross-head are enclosed by a casing, which, with the bed or frame of the engine, forms a chamber in which these parts may run. A bath of oil fills the lower part of this chamber to such a depth that at each revolution of the crank the end of the connecting-rod is partly submerged in the oil, while the crank-disk is always in contact with the oil bath. The result is that the oil is thrown into every part of the chamber, so that the crank-pin and cross-head pin and the cross-head slides practically run in an oil bath.

Objections have been raised to this method of lubrication on the grounds that the oil is not clean after a short period of running, since it contains the particles worn from the journals and brasses, as well as

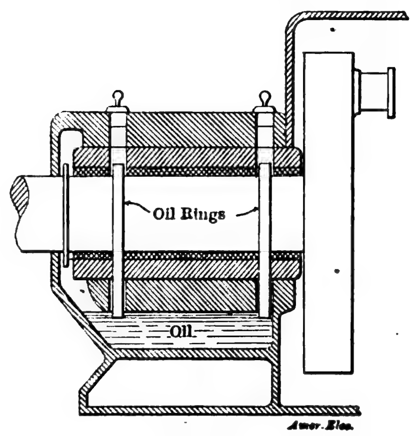

FIG. 11.

the dust that will find its way into the chamber, in spite of the best of care. In some engines, also, the condensation due to the leakage of steam from the stuffing-box mixes with the oil and this mixture is less valuable for lubricating purposes than clean oil.

It is furthermore urged that the splash method of lubrication possesses a very disagreeable feature in that when it becomes necessary to tighten the crank-pin in brasses or the cross-head shoes, the parts are all covered with oil.

Some builders avoid this method of oiling by substituting a continuous system, in which the oil is fed from some reservoir to the various engine bearings, the drippings caught, filtered and returned by a pump to a reservoir for further use. This forms a very clean and desirable mode of lubrication, which is growing in its application. One advantage is that the oil which reaches the bearings is always clean, and, therefore, in the best condition to perform its proper function.

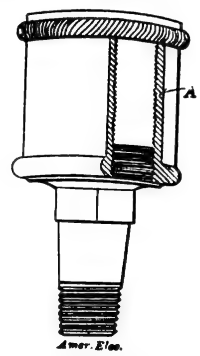

FIG. 12.

It is important that the eccentrics be well lubricated, since they are usually of considerable diameter and a large resistance due to friction is felt more quickly than on a shaft or pin of small diameter. An ordinary sight-feed oil cup is sometimes screwed into a hole tapped in the eccentric strap, and this does very well for intermittent running. But for long, continuous running, the oil cup must be stationary, so that it can be refilled easily. The telescopic oiler previously described may be used for eccentrics, and it answers the purpose admirably. Another very common form of oiling device for eccentrics is shown in Fig. 10. It consists of a long, narrow trough, *A*, terminating in a threaded tip which is screwed into the oil hole in the strap. The length of this trough is made slightly greater than the throw of the eccentric, and the oil pipe, *B*, from the cup is fixed vertically above the trough, so that the oil will drop into it, no matter what the position of the eccentric.

The usual method of oiling main bearings is by sight-feed oil cups screwed into the caps of the bearings, the distribution of the oil being secured by means of grooves cut in the seats of the bearing. In the larger engines this gives place to the gravity system already described. In other cases, principally in small high-speed engines, the ring oiling system is used, as illustrated in Fig. 11. As may be seen, the shaft is encircled by several rings which are much larger in diameter, internally, than the outside diameter of the shaft. These rings dip into a bath of oil formed in the base of the pedestal or frame, and, rolling on the shaft as it turns, carry oil to the top of the shaft, whence it finds its way, by spreading, to the bearings. In some cases the rings are replaced by loops of chain, but the action remains unchanged.

Thus far, only oiling devices have been considered. However, the use of greases for lubricating crank-pins and cross-head pins, as well as the various pins in the Corliss valve gear, has become quite extensive. These greases are fed from cups attached to the pin and moving with it. Frequently, the rate of feed is dependent upon the heat developed by friction in the bearing, this heat melting the grease and causing it to flow. Cups are made, as in Fig. 12, by which the feed can be regulated by hand. Screwing down on the cap, *A*, at intervals, forces the grease down to the pin. One of the best ways of feeding grease, however, is to use a spring compression cup in which a piston actuated by a helical spring, presses upon the grease in the cup and forces it out to the bearing. The tension of the spring may be adjusted to suit the consistency of the grease, and the outlet valve may be set so as to give the proper rate of feed.

A NOVEL STORAGE BATTERY.

BY DR. ALFRED GRADENWITZ.

A novel accumulator is being brought out in Germany in which the two electrodes are made of lead and zinc peroxide. Heretofore use of this couple has suffered serious drawbacks inasmuch as the zinc was dissolved by local action, thereby rendering its use in a storage battery practically impossible. Apart from this disadvantage, there was the difficulty of recharging such a battery, so that the couple referred to could practically be used only as a primary cell; that is to say, it produced electricity by the combustion of zinc. This confined its practical use from the very outset within rather narrow limits, since the cost of electricity produced from zinc is quite prohibitive.

In an endeavor to obviate the disadvantages of lead-zinc batteries, Mr. O. Von Rothmund constructed a regenerative primary element in which the zinc plates as they

became worn out were replaced by others, while the discharged lead peroxide plates were replaced immediately by other charged peroxide plates or were recharged themselves. The excessive consumption of zinc in this battery rendered its use to any large extent quite impossible, although a very high capacity was obtained.

Mr. Von Rothmund has recently succeeded, in conjunction with the firm of Ziegenberg & Co., of Berlin, in further increasing the advantages of the lead-zinc battery, the outcome being the storage battery shown in Fig. 1. In order to avoid any useless expenditures of zinc in the intervals of operation, a zinc alloy has been substituted, which, it is claimed, may be left in diluted acids for many weeks without any considerable amount being dissolved.

Engineers are aware of the difficulty of precipitating zinc by means of electricity in the form of a dense and adhesive coating on some other body. This difficulty is increased if zinc is to be precipitated on a zinc electrode. An extensive series of experiments was made in order to develop a process by which the lead peroxide electrode might be recharged and a zinc coating obtained simultanenously on the zinc electrode to render the latter suitable for immediate discharge. The lead-zinc battery thus passes from a primary cell to a secondary cell, although possessing features considerably different from those of ordinary lead accumulators.

The cell is said to produce 50 watt-hours per kilogram of battery in working order, and this may be increased to 70 or 80 watt-hours without interfering with its life. These high figures are due to the joint presence of different circumstances. In the first place, the couple, lead peroxide-zinc, represents a higher energy than is found in lead storage batteries, the ratio of the mean voltages being 2.35 to 1.95. A further increase in the capacity is obtained by using zinc plates which are thinner than lead sponge plates. The lead peroxide plates used in the new battery are also made by a special process, so as to possess excellent qualities, both from an electrical and mechanical point of view. Despite its mechanical strength, the plate is said to be extremely porous, which obviously insures a high capacity. Experiments made have shown the battery to successfully withstand short-circuits of several hours' duration, while yielding for short intervals twenty times the normal current; and this, without impairing its mechanical durability or decreasing its capacity to any permanent extent. As regards the life of the battery, no definite opinion can yet be had, as the results so far obtained do not extend over a sufficient period of time. Some positive plates are, however, available which have been discharged several hundred times, and these have, to all appearances, lost nothing in capacity or strength.

The mechanical strength of the battery is due to its practical design, as may be inferred from Fig. 1. A large hard-rubber box is separated into six compartments by hard-rubber partitions, and the whole is suspended in a protected casing of aluminum. The positive and negative plates are secured to frames on the edge of this aluminum casing. Each frame is placed on an elastic piece of rubber tubing and embedded in soft rubber. Connection of the plates with the various elements is effected by a system of springs. All solid connections are thus avoided. The plates are suspended in the hard-rubber box which only acts as the bearer of the electrolyte. This construction has been followed with a view to making the batteries of service in automobiles.

Regarding the practical operation and charging of the battery, there are various possibilities. As a zinc plate can be used in connection with several discharges the charge can be renewed by simply exchanging the set of positive plates for another freshly-charged set after renewing the acid. A greater advantage is offered by another

FIG. 1.—LEAD-ZINC BATTERY.

process in which the freshly-charged plates, before being placed in operation, are soaked in a vacuum apparatus with sulphuric acid. By this means the plates contain a sufficient amount of concentrated acid to be available for operation after being fitted up by merely pouring pure water over them. This soaking process affords other advantages, for the plates after being soaked have merely to be preserved in hermetically-closed vessels, in which state they can be kept a very long time without losing any of their charge. This affords a very suitable means of generating electricity in places having no central station or current mains. Current may be obtained by merely replacing the discharged positive plates by a set of charged or soaked plates. It should be remembered that the repeated use of zinc plates does not entail a consumption of zinc. The liquid remaining in the cell, which is an acid zinc sulphide solution, is used for direct recharging, so that the zinc in solution is recovered. The same zinc plates which have been used for several discharges are accordingly used for several recharges as counter electrodes with various sets of positive plates. Both sets of plates can, however, be recharged immediately after each discharge.

THE VALUE OF CONTACTS.

The importance of close contacts in the maintenance of circuit continuity has long been appreciated by electrical engineers. In the early days of telegraph and cable work the effect of a single loose connection at an instrument binding post was found to be sufficient to paralyze hundreds of miles of otherwise perfect line, and the years of experience which culminated in the commercial electric light and motor constantly brought home the lesson of the tight contact. In the signalling world it never has been a question of maintaining close contacts to prevent the dissipation of energy in heat, but the point has been, and is today, the preservation of the continuity of the circuit for the sake of the intelligibility of the signals themselves. Since the advent of the telephone the loose contact has been outlawed from all well regulated circuits, and there is no doubt that the wonderful sensitiveness of the Bell receiver is indirectly responsible for much of the improvement in circuit design exhibited in modern signalling apparatus, and anyone who examines the wiring of a modern central energy lamp signal relay telephone switchboard for the first time cannot but be impressed with the dependence of the industry upon soldered instead of twisted or clamped connections.

As one enters the power field the contact points in the circuits assume a new significance. Here the problem is distinctly a question of keeping down the temperature rise caused by the I^2R loss at the joints. If the contact is poor and the power supply ample, the resistance develops so much heat by the passage of the current that in time the switch points or blades become welded to the jaws—"frozen" in street railway parlance—and if the temperature still rises, the circuit finally breaks through the melting of the conductors, unless the fuses go first, which is generally assumed to be the proper order of events.

Even if the switches or connecting wires do not melt and set the premises on fire, but simply turn greenish-blue with heat, energy is being wasted to the detriment of the reasonable profits of the enterprise. Given plenty of power behind the switch, heavy overloads will cause trouble even in liberally designed contacts. There is always a point beyond which it will not pay to go in designing contacts, but after the maximum cross-section permissible has been named, it is still possible to increase the carrying capacity of the contact surfaces by the introduction of mechanical pressure by springs, compressed air or some other agency.

The influence of pressure upon contact resistance has been utilized in certain rheostat constructions, but the relation between the contact pressure and the temperature has not been widely appreciated. In a recent test of pneumatic unit switches designed for the Westinghouse multiple unit control system it was found that with a contact of one

inch and a pressure upon the contact of about 35 lbs., 300 amperes could be carried continuously with a temperature rise of 80 degrees, whereas with a pressure of 125 lbs. the temperature rise was but 50 degrees. With 210 lbs. pressure the rise was but 30 degrees, and at the latter pressure the same contact carried 600 amperes or 100 per cent. overload with 90 degrees rise. With 300 lbs. pressure 600 amperes gave 70 degrees rise. Supposing 70 degrees to be the limit of temperature rise allowed in a given case, the above switch would then carry anywhere from 300 to 600 amperes continuously provided the range of pressure available lay between 60 and 300 lbs. The use of compressed air in this way enabled the contact to be opened by springs powerful enough to act under almost any conditions which could be suggested, the usual magnetic blow-out principle being employed to prevent heavy arcing. In the light of these facts it is certain that the quantitative study of contact pressures is well worth while in large capacity switches and connections.

DIRECT-CONNECTED MOTORS IN TEXTILE WORK.

BY H. S. KNOWLTON.

The textile industry illustrates one of the most interesting fields of electric motor application, but until quite recently the group system of driving has been practised to the entire exclusion of direct-connected installations. This uniformity of motor application has been the natural result of service conditions demanding little or no speed variation in the individual processes of weaving and spinning, and it presents a marked contrast to the practice followed in machine tool driving, where speed variation constitutes one of the most essential elements of economical production.

Of late years competition in the textile industry has been keen, particularly between different sections of the same country, and the importance of lowering the production cost of each unit of output has been widely appreciated. Although the cost of power is not a large percentage of the total cost of manufacture in the textile industry, far-sighted mill managers have begun to see that any saving which can be effected without too great an initial expenditure is decidedly worth securing. The direct-connected motor is, therefore, being brought to the front in the interests of broad operating economy, and although these applications are still in a process of evolution, enough has been learned in actual commercial installations to determine pretty definitely the relative economy of direct connection and group driving in specific cases. The application of direct-connected motors to looms and spinning frames has passed far beyond the experimental stage, but in the close study now being devoted to the subject, minor improvements are constantly being introduced.

The individual drive received attention in Europe much earlier than in the United States, and as far back as 1894, motors were direct-connected to looms in households and factories in the vicinity of St. Etienne, France, with thoroughly satisfying results. Other installations followed, and in Lancashire, England, induction motors were direct-connected successfully to the ring frames in the cotton mills. Practically all the important textile driving in America and Europe has been done with alternating-current motors, which commend themselves particularly for this service on account of their elimination of sparking and resultant fire risk reduction, coupled with exceedingly low maintenance cost. Lint and dust constitute an inflammable combination in textile mills which deserves to be freed from the possibilities of ignition introduced by the sparking commutator. Squirrel-cage armatures are, therefore, widely employed in the induction motors used in textile establishments.

The advantages of the direct drive in textile work are considerable. One of the most important is the simplicity of the power installation, which requires no shafting, pulleys, belts, ropes or elaborate gearing. As the actual amount of power required to drive each individual textile machine is small, the friction losses in the shafting and belts of a group-driven system become of great relative importance. With the individual drive a better subdivision of power is possible and the elimination of long lines of distributing shafting does away with losses in transmission, which, in a large mill, foot up to an unpleasant total in the course of a year's run. Overtime work can be carried on at any machine or number of machines with the direct drive, and at almost nominal expense for power in comparison with the cost of thus operating with a belted system. Another great advantage is found in the more uniform speed of the direct drive, which results in an increase in the rate of production, with fewer brakes and a better grade of goods. The goods are further improved by the better light secured through the absence of belts and shafting, and the elimination of oil and dirt common to belted installations is perhaps one of the greatest advantages of the individual drive. A single spot caused by a drop of oil falling upon a piece of silk or velvet in the process of weaving is enough to ruin the goods, and on this score alone it is safe to say the use of direct-connected motors is often entirely justified. The production rate of looms has been shown by actual test to be increased from 5 to 7 per cent when the individual drive is employed. In one installation the worst loom in the mill was equipped with a direct-connected motor. When belt-driven this loom gave so much trouble that no operator was willing to remain and work with it. After the motor was applied it was found that the loom turned out as much work as the best machines in the mill, and the attendant in charge became unwilling to leave the loom for any other.

With direct connection, in case an accident happens to any loom or to any part of the driving mechanism, only one machine is rendered inoperative, whereas, with the usual belt-driven arrangement, if the main belt breaks, or any of the shafting becomes disarranged, the entire section, comprising many looms, has to be shut down, with a resulting reduction of output. In new plants the absence of shafting and belts permits a material reduction in the cost of the building construction.

The idea has been widely held that because the first cost of a direct-connected electrical outfit is often almost double the investment required for the group-driven system, it will not pay to install the former scheme. It is easy to demonstrate the falsity of this conclusion by drawing upon figures from actual practice. In a certain mill which manufactures cotton duck the weave room was originally equipped with a 65-h.p. induction motor and shafting, from which the looms were driven by belts. The first cost of the motor was $985; the belts and shafting cost $1970, making the total investment $2955. Not long since the individual drive was substituted, in the form of 10 1-h.p. and 64 ½-h.p. Westinghouse type C induction motors. The ten larger motors cost $760 and the smaller ones $4150, making a total of $4910. The difference in the investment was, therefore, $1955 in favor of the group drive. However, tests showed with the individual drive a saving of 15 horse-power otherwise lost in belt and shafting friction, which would cost $375 per year at the moderate steam plant production cost of $25 per horse-power per annum. The interest on the excess cost at 5 per cent came to $98 per year, leaving a saving of $277 per year in favor of the individual drive. Simply on the basis of annual power saving, the latter drive, therefore, will pay for itself inside of 7 years, to say nothing of the money value of the increased production resulting.

In another recent case the first equipment of a spinning room was a 65-h.p. motor costing $985. The belts and shafting came to $798, making $1779 for the installation. This was replaced by 18 motors rated at 3 horse-power each, representing an investment of $1830. The annual saving in friction loss was 7 horse-power, or $175 at $25 per h.p.-year. In this instance the cost of replacing the old equipment with direct-connected motors was so slightly in excess of the original investment that even if there had been no saving in friction losses it paid to make the change on account of the general advantages of the direct drive. The second-hand value of the original installation was not figured and the difference in efficiency between the large motor and the several smaller units was not considered of sufficient importance to affect the decision. In each case the wiring came to practically the same cost. When speed variations are desired with direct-connected equipment, the present practice provides for the change by altering the motor pinion, moving the motor backward or forward to correspond with the change in gear. Automatic stops are provided to bring the motor to a standstill immediately in case a thread breaks, and in the later direct-connected equipments the motor is controlled through the shipper handle in order that the attendant shall be able to operate his machine in the same manner as though it were belt-driven.

Hydro-Electric Development in Italy.

THE 36,000 VOLT TRANSMISSION PLANT AT MONTEREALE-CELLINA.

BY L. RAMAKERS.

Among recent installations for the generation and transmission of electric power the hydro-electric plant at Montereale-Cellina, Italy, which supplies electricity for lighting and power purposes to Venice and the surrounding districts, is worthy of attension. Power to operate the generating units is taken from the Cellina, a river having its source in the Carnic Alps and delivering at its lowest ebb 30,000 litres of water per second. Many difficulties were encountered in the construction of the plant, which has cost more money and labor than any other in Italy. A masonry dam across the narrowest part of the river serves the double purpose of raising the water level at the intake and creating a reservoir of about 300,000 cubic meters at periods of very low water. Four large sluices regulate the overflow and are operated by electric motors fixed on the bridge which crosses the whole construction. The intake proper is formed by two rectangular mouths, 2 meters wide by 3 meters high, adjustable by sluices. A canal, 4328 meters long, partly cut in rock, supported by a series of walls, arches and galleries, completed on the river side by a wall with an external slope, and cemented inside, leads from the intake to the opening of a large tunnel. This tunnel is 1073 meters long and has the same gradient and section as the canal. It is cut entirely in califerous rock and empties into another canal leading to a small lake having an area of about 2400 square meters, in which matter in suspension is allowed to settle before the water reaches the turbines. Six large penstocks lead from this lake to the main generators, and a seventh penstock is divided into two branches for small exciter turbines.

FIG. I.—INTERIOR OF THE GENERATING STATION.

The main station is situated near the village of Malnisio. This consists of a central building with two projecting wings and an annex on the west side. The eastern portion contains a workshop for repairs, warehouses, offices and living rooms for the engineers and workmen. The main generating units occupy the entire central portion. In the western part, in a room leading from the turbine room, are the switchboard, switches and lightning arresters, and the step-up transformers are located in the annex. The turbines discharge water at a level of 281 meters. The level of the dam is 339.64 meters, so that the head available is 58.64 meters. With a discharge of 20 cubic meters per second, which represents the minimum power, there is available 15,600 horse-power, with a maximum of 18,900 horse-power.

Inward-flow reaction turbines, having a single wheel and horizontal shaft and two lateral discharges (one on each side), are installed to utilize this power, the smaller turbines for the exciters having a single discharge. At present there are but four turbines installed, but provision is made for six, it being intended to use one as a reserve. Each turbine consumes 4500 litres of water per second and develops 2600 horse-power at 315 r.p.m. The turbines for the exciters, which are smaller but similar in construction, are three in number and develop each 200 horse-power at 500 r.p.m. The larger turbines are direct-connected through rigid couplings to three-

phase alternators furnished by Brown, Boveri & Co.

The alternators have fixed armatures and rotating fields. The exciting current can be adjusted so as to vary the voltage at the terminals from 3600 to 4800 volts. The normal tension of the alternator with non-inductive load is 4000 volts at a frequency of 42 cycles. The commercial efficiency of the main units under full inductive load is 95 per cent. The fall of potential between no load and full load with the usual speed and exciting current is 5 per cent of the normal voltage with non-inductive load, and 16 per cent with an inductive load.

Direct current for exciting the fields of the alternators is provided by dynamos direct-coupled to the smaller turbines. These dynamos are shunt-wound machines with six poles and drum armature, and generate current at a potential of 200 volts. The commercial efficiency of these machines at full load is 93 per cent. Three alternators are at present capable of carrying the load, the output from two being transmitted, while the output of the third is used for local service.

Transformers of the single-phase type are used in preference to those of three-phase in stepping up the potential for transmission, since it is desirable in case of large units to limit as far as possible the damage and cost of repairs in case of an accident, and since it is also advantageous to heighten the tension when necessary by altering the connections from the mesh to

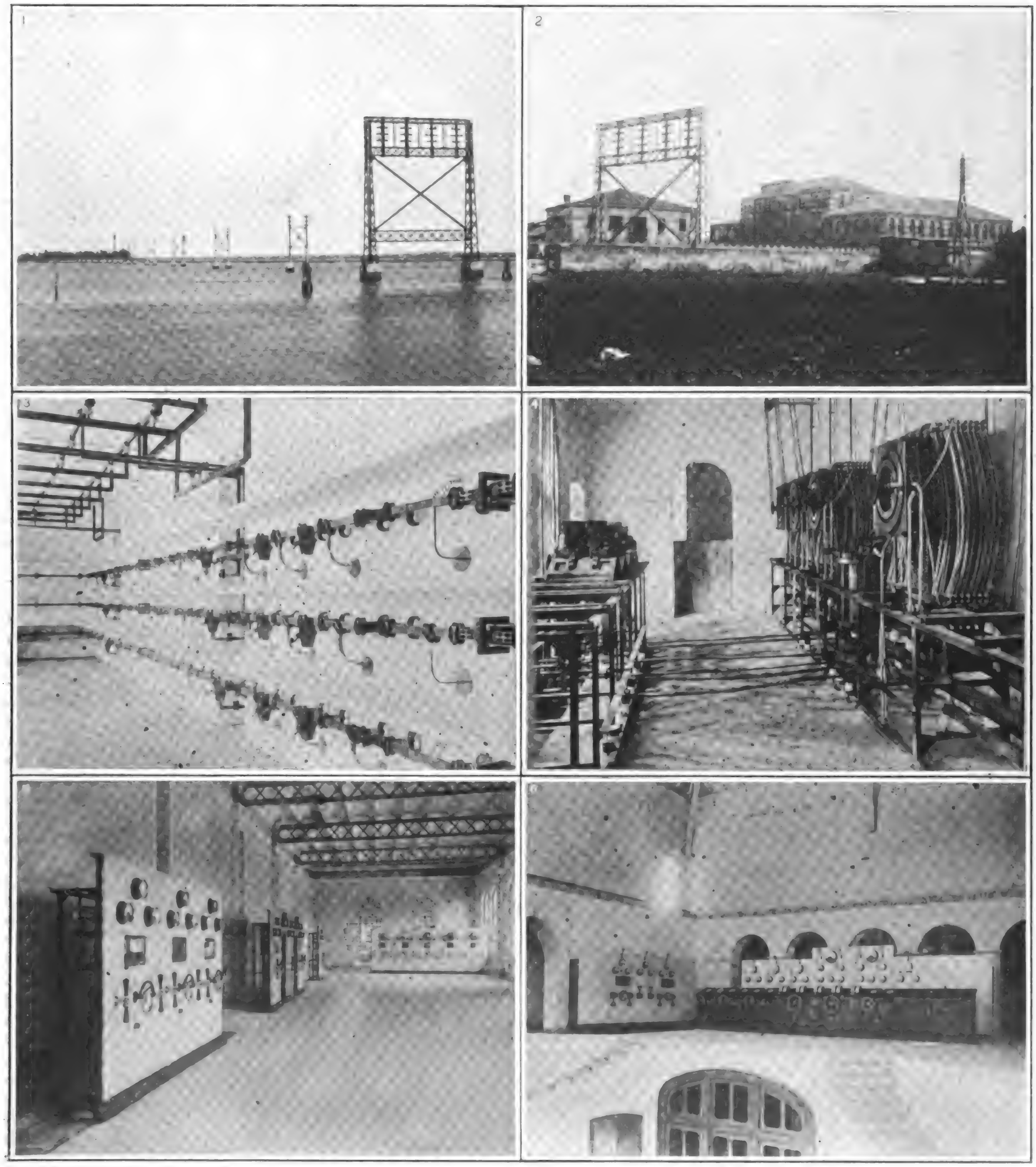

FIG. 2.—MONTEREALE-CELLINA TRANSMISSION PLANT.

1.—36,000-volt line across the Lagoon. 2.—Station at Venice. 3.—High-tension Bus-bars. 4.—Field Rheostats. 5.—Low-tension Switchboards. 6.—Main Switchboard.

the star system. The transformers have been chosen with reference to the capacity of the line they are intended to eventually feed. When the installation is complete the transmission line will consist of four groups of three conductors each and will carry a load of 12,000 kilowatts. The transformers installed are of 1000 kilowatts capacity, so that each bank of three will feed a group of three wires. Normally each bank of transformers will be connected with a given group of wires without any connection in parallel on the high-tension side with the other groups, so that in case of a lightning discharge on the line, only those transformers connected with that particular line will be affected. Fifteen transformers will be ultimately installed, the fifth bank of three being held in reserve in case of accidents to any of the other banks. The ratio of transformation in these transformers is 7.5 to 1, so that with a primary voltage of 4000 the secondary tension will be 30,000 volts, which will be increased to 36,000 volts, with a maximum primary voltage of 4800 volts. The commercial efficiency of the transformers with unity power factor is guaranteed to be 98 per cent. The alternators are separately connected to a system of collecting bus-bars in the shape of a closed ring which is divided into multiple sections by knife switches. This ring of collecting bars is in turn connected with the various banks of transformers, so that it may be considered as divided into two parts—one in which the energy comes in and the other in which the energy goes out—and the integrating wattmeters are placed between the two.

The working transformers are connected directly to the lines through lightning arresters, while the spare transformers are connected to a system of auxiliary bars which can also be used to place the transformers in parallel on the high-tension side if this is desired. The switches are all of the oil-break type, the 4800-volt switches being double-break and enclosed in an oil compartment, while the 3600-volt switches are of the six-break type and enclosed in three separate oil compartments, one for each phase. All the switches are operated from a distance by means of levers controlled by hand from the switchboard. Automatic circuit-breakers are installed to open the circuit as soon as the current reaches a predetermined limit. The lightning arresters are of the Wurtz type with four self-induction coils and with four paths to earth by means of the usual series of non-arcing metal cylinders. Before discharging through the Wurtz apparatus, however, a discharge may find its way to earth through a double-horn lightning arrester and also through a lightning arrester of the Gola type.

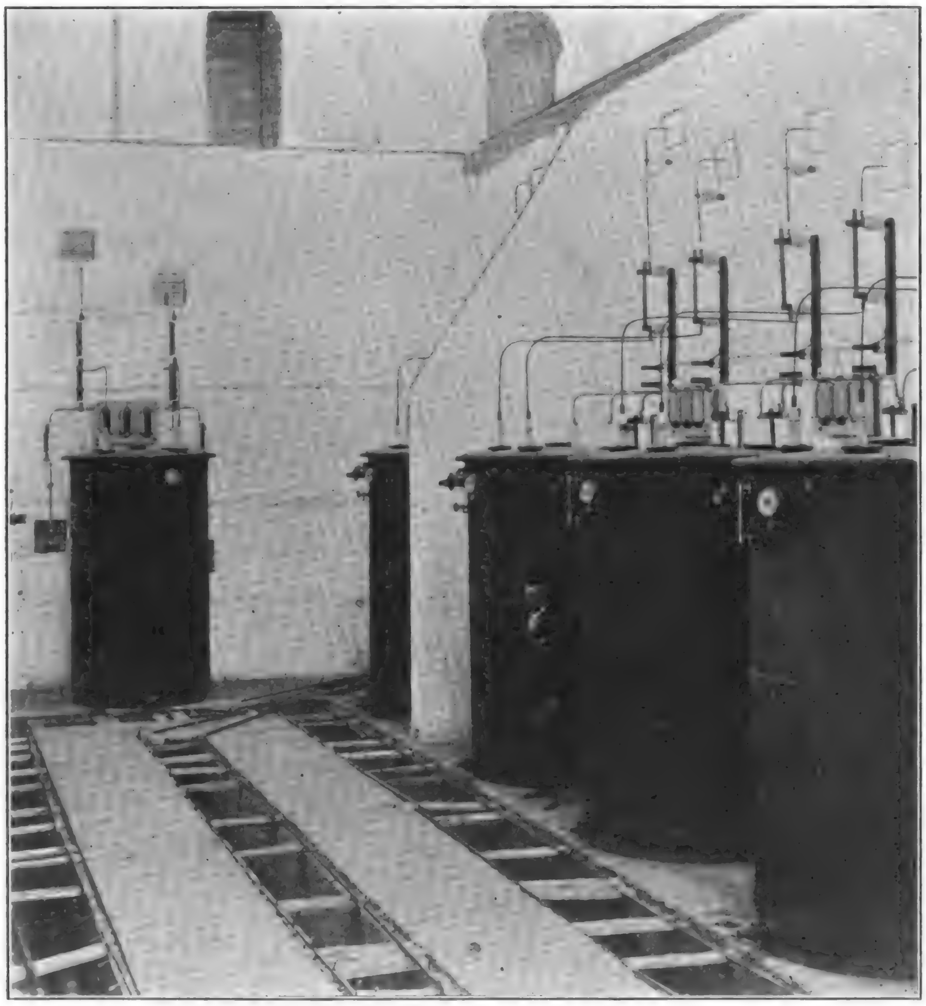

FIG. 7.—STEP-UP TRANSFORMERS IN MAIN STATION.

Beneath the engine room and situated in large tunnels are the conduits for the 4000-volt circuits and the 200-volt circuits of the exciters. These conduits, which are widely separated, lead to one end of the building and pass thence to the switchboard. This is divided into two distinct parts, one controlling the direct current and containing switches, collecting bars and rheostats for the field circuits of the alternators, all of which are worked from the upper platform; the other for the 4000-volt, three-phase current. A masonry partition is provided for each alternator circuit. This partition is divided into two parts, the lower part for the automatic switch worked from the upper platform, and the upper part for the measuring transformers for the switchboard instruments. A similar arrangement prevails for the circuits connecting the collecting bars with the transformers. The adjoining room is used exclusively for the rings of collecting bars, which are fitted along the walls and on the ceilings and are separated from each other by slabs of reinforced concrete. After passing to the switches, the conductors connecting the rings with the transformers descend to the lower floor, where in groups of three they pass through the transformer room to the annex. The 36,000-volt conductors pass above these. The whole complicated installation is controlled from the platform of the switchboard which is at one end of the room and contains a central board and table for working the switches and two lateral boards. The central board carries the ammeters, voltmeters, wattmeters and relays for the automatic switches, and the ammeters and integrating wattmeters connected between the two halves of the bus-bars. The working table carries the hand wheels controlling the switches and the rheostats for the field circuit, the ammeters and exciting switches, the voltmeters and phase indicators. At present there are seven main switches installed, two of which are automatic. After passing through these and the transformers for the ammeters, the conductors go to an upper story where six rows of lightning arresters are located, and pass out of the station and overhead by a double row of poles to Venice. The mean distance between the poles is 55 meters, and in the lagoon district about 4 kilometers of the line is supported on iron lattice work. The current arriving at Venice has a potential of about 27,800 volts, the transmission loss being 7.35 per cent on unity power factor, and 12 per cent with a power factor of 75. The current is stepped down at Venice to 6200 volts through nine transformers of 900 kilowatts capacity each. These transformers are similar in design to those in use at the generating station. The lightning conductors and switchboards in use at Venice are also similar to those used at the generating station, and the same may be said regarding the distribution of the various apparatus. A similar system of rings of collecting bars is also used. Two additional rings are installed as reserve, and it is intended to eventually use these to enable the lighting and motor loads to be separated. Sufficient space has been provided for fourteen outgoing leads, although at present only nine are installed—six for motor service and three for lighting

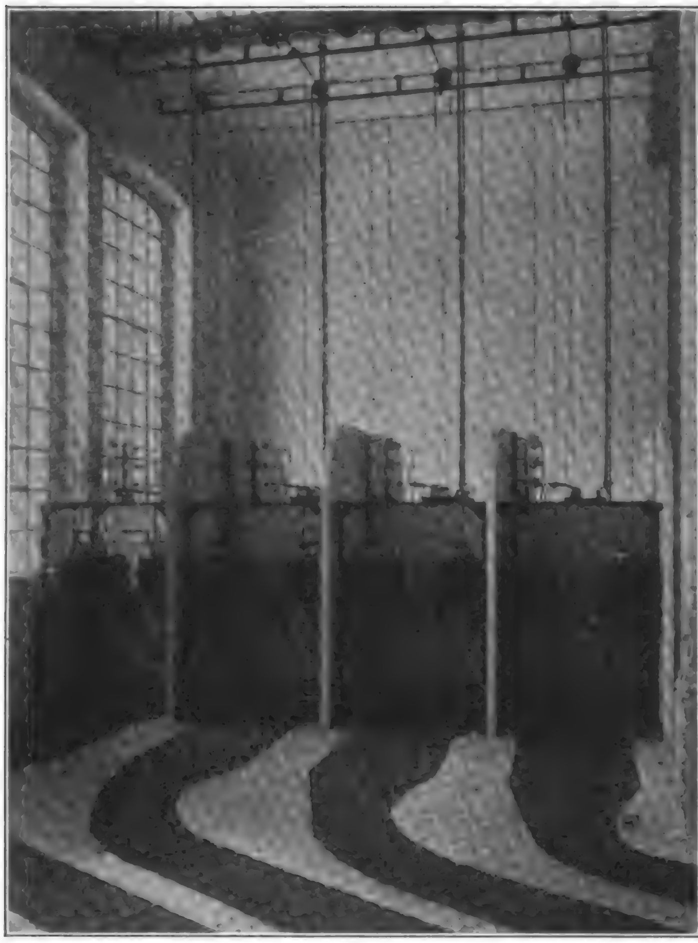

FIG. 3.—SWITCH GEAR IN SUB-STATION AT VENICE.

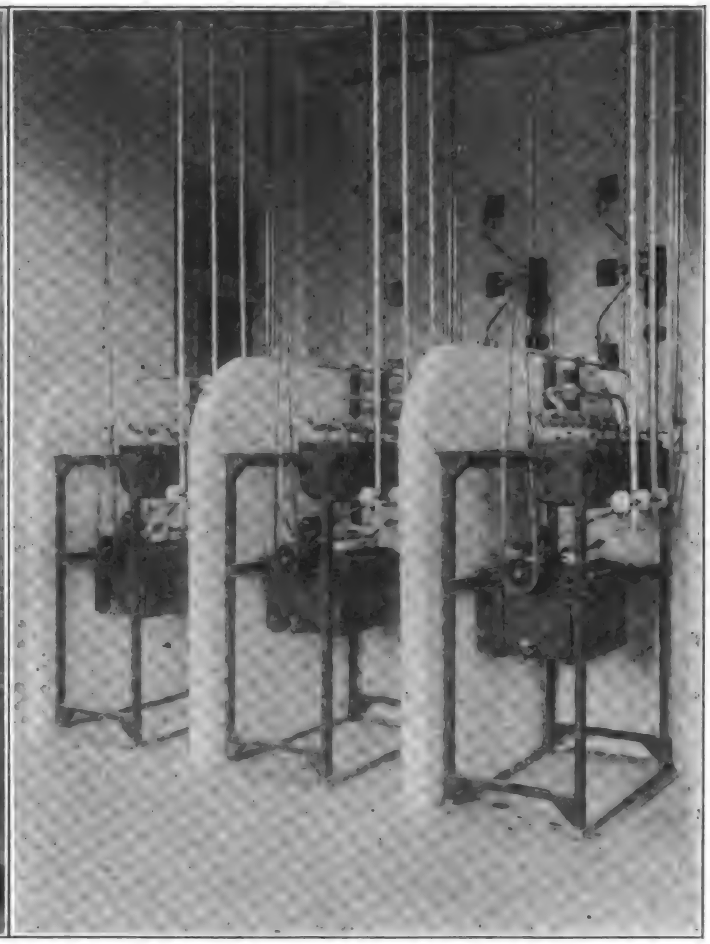

FIG. 5.—SWITCH GEAR IN MAIN STATION.

FIG. 4.—HIGH-TENSION BUS-BARS IN SUB-STATION.

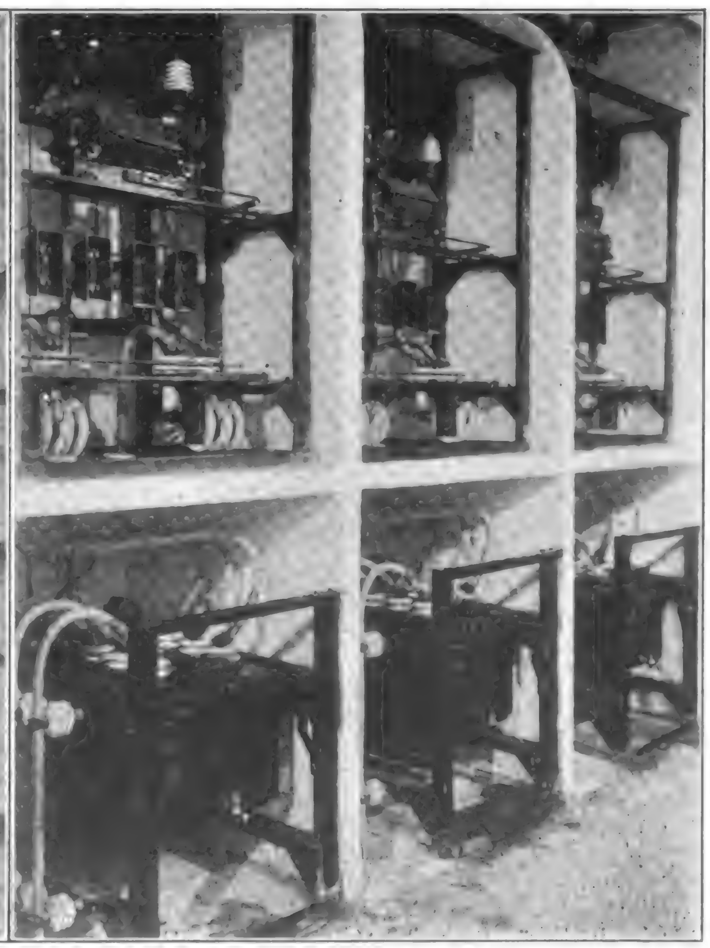

FIG. 6.—INSTRUMENT TRANSFORMERS AND GENERATOR SWITCHES.

service. These leads are fitted with Wurtz lightning arresters combined with cut-outs and liquid resistances. The drop of potential in the lines in the urban service is about 3 per cent, and for this reason a tension of 6000 volts is maintained at the main supply stations. The lines are all placed overhead, and where they cross the canals the wires are kept at a height of at least the field circuits of the alternators, all of 18.50 meters above high-water level. Of the six power leads, two go to the Arsenal, two to the Dorsodura and Santa Croce, and two to the Isola della Guidecca, the main center of Venetian industry. All these leads are of bare copper wire. The leads for the lighting service are the property of the community. These are of insulated copper wire and traverse the city in various directions, converging at the electric station of S. Luca, where the tension is reduced from 6000 volts to 2000 volts, so as to feed the transformer leads of the existing lighting plant, which operates at this tension. Each of the three new lines intended for the lighting service may be divided into various parts between the sub-transformer stations through oil switches. Thirty sub-stations are to be installed. These will be fitted with transformers of

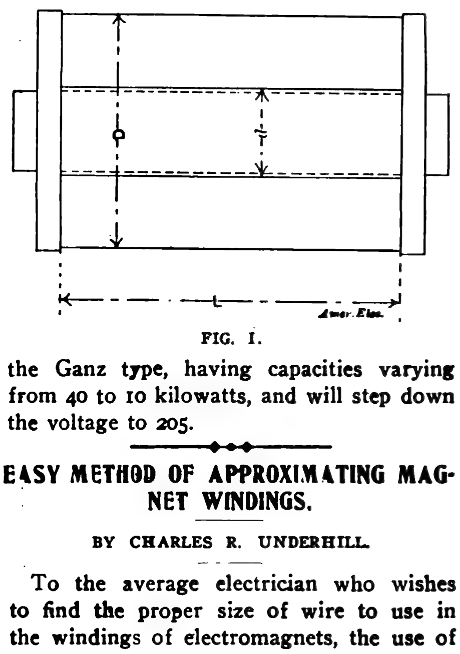

FIG. 1.

the Ganz type, having capacities varying from 40 to 10 kilowatts, and will step down the voltage to 205.

EASY METHOD OF APPROXIMATING MAGNET WINDINGS.

BY CHARLES R. UNDERHILL.

To the average electrician who wishes to find the proper size of wire to use in the windings of electromagnets, the use of winding formulæ is often confusing. The graphic system, however, not only eliminates the necessity of formulæ, but makes the whole operation clear and simple.

In describing each of the accompanying charts actual cases will be cited to facilitate following the methods employed. No reference will be made to the theory of the electrical constants or how the charts are made.

In order to find the proper size of insulated copper wire to fill a given winding

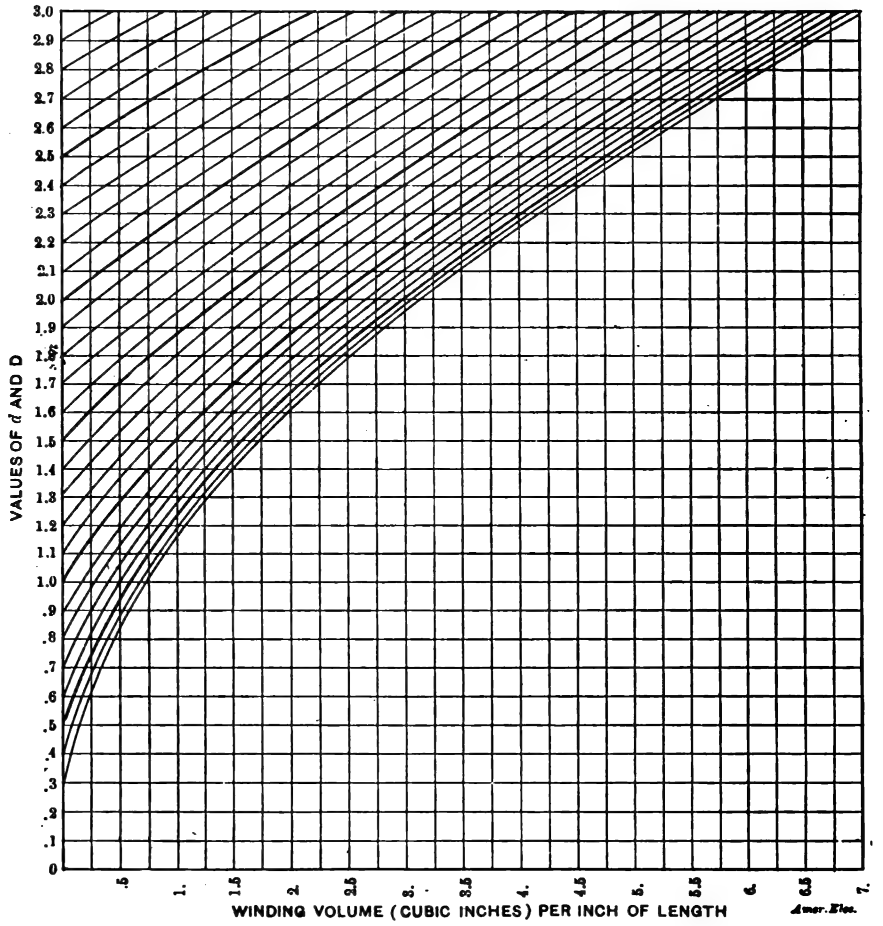

FIG. 2.

space, and have a given resistance, it is necessary to know the cubical contents of the bobbin, or the actual volume of the winding space in cubic inches, and the ohms per cubic inch for the various sizes of copper wire with various increase in diameters due to the insulation. Therefore, if the winding volume of a bobbin be 2 cubic inches, and the ohms per cubic inch 250, the resistance of the winding would be 500 ohms. It is very important that the actual available winding space should be taken; that is, the space which is left after the bobbin is properly insulated.

As most windings for electromagnets are wound upon a round core or tube, the round type of bobbin will be assumed throughout this article. This bobbin is illustrated in Fig. 1.

Referring to Fig. 2, the winding volume (in cubic inches) per inch of length of winding is found by following the curved line, which starts from the value of d, the inside diameter, to where it intersects the horizontal line corresponding to the value of D, the outside diameter, and then tracing vertically downward.

As an example, the outside diameter of a winding is 2 inches and the diameter of the insulated core, d, is .9 inches. Following the curve which starts at .9 it will be found that it intersects the horizontal line corresponding to 2 at the vertical line corresponding to 2.5 cubic inches per inch of length of winding. If the length, L, be 3 inches the volume of the winding will then be $2.5 \times 3 = 7.5$ cubic inches.

The charts, Figs. 3 to 8, show the ohms per cubic inch for various diameters of

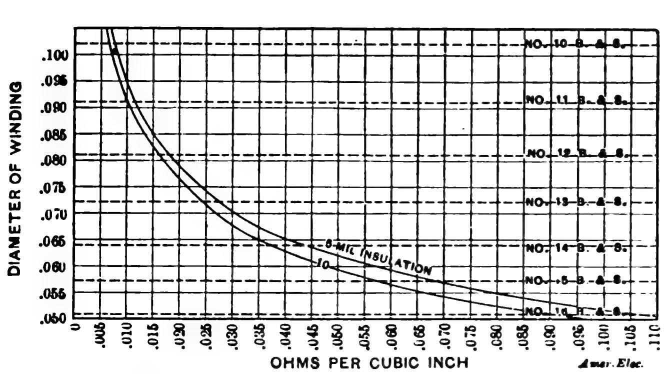

FIG. 3.

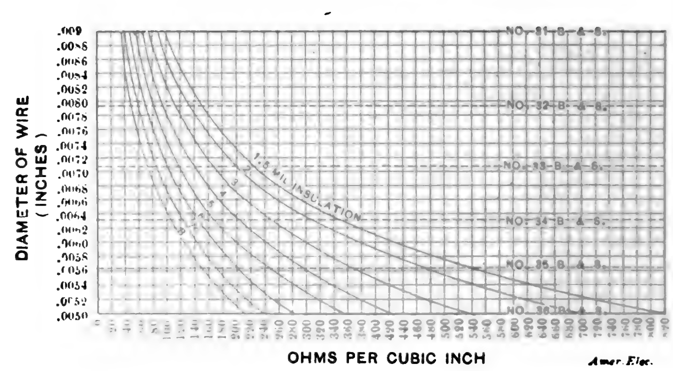

FIG. 7.

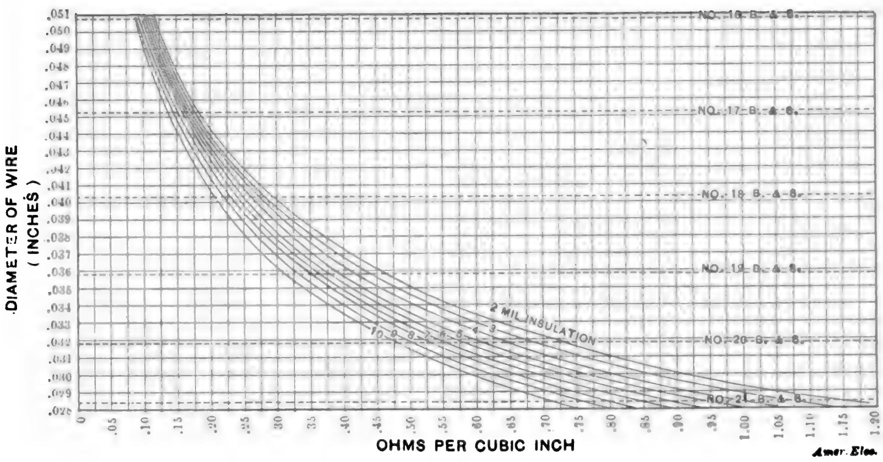

FIG. 4.

copper wire irrespective of the gauge number, with various increases in diameter due to insulation. A 4-mil increase means that the diameter of the insulated wire measured over the insulation, is 4 mils greater than the diameter of the bare copper wire. For convenience, the different sizes of wire of B. & S. gauge are shown in dotted lines, in positions corresponding to their diameters.

Although the increase in diameter due to insulation on the wire may vary with different manufacturers, the increase in diameter due to single silk insulation varies from 1.5 mils to 2.5 mils, and from 3 mils to 5 mils for double silk insulation. For cotton-covered wire the increase in diameter varies from 4 to 5 mils for single cotton, and from 8 to 10 mils for double cotton insulation. In any event it is well to caliper the insulated wire with a ratchet stop micrometer, to ascertain the increase in diameter due to the insulation.

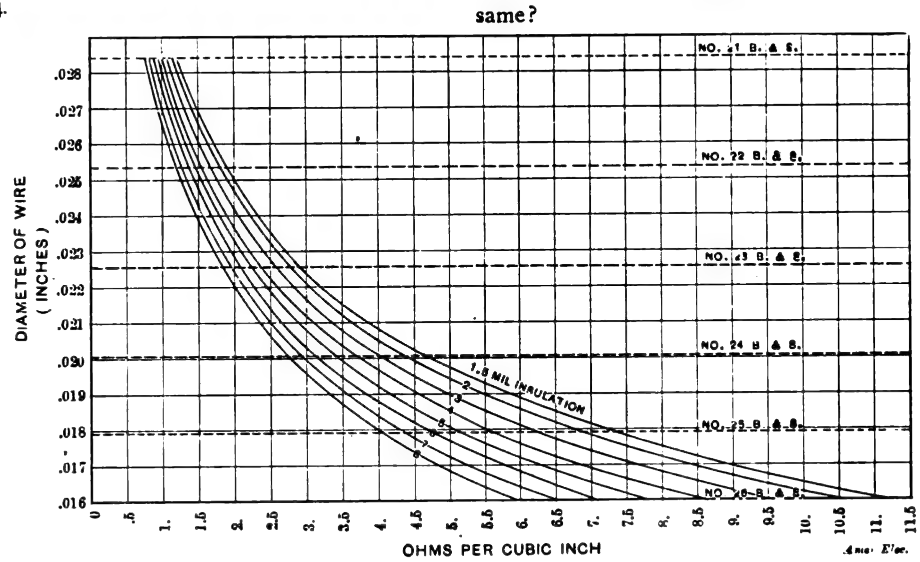

FIG. 5.

As an example of the use of these charts, refer to Fig. 5 and assume that an insulated copper wire is desired which shall have a resistance of 4 ohms per cubic inch when wound on a bobbin. Tracing vertically upward from 4 it will be found that this result is obtained with a wire .018 inch in diameter, with 8 mil insulation, or with a wire .0184 inch in diameter with 7 mil insulation, etc., the largest diameter of copper being obtained with 1.5 mil insulation, the diameter of the wire being .0208 inch.

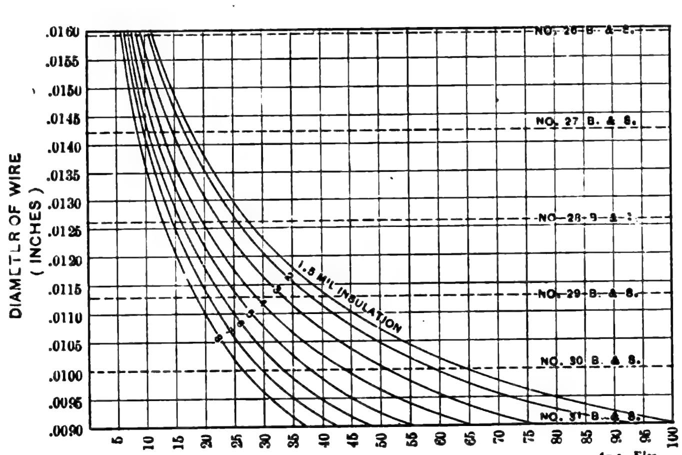

FIG. 6.

Therefore, if the 8-mil insulation be used a No. 25 B. & S. wire would be used, while with even 3-mil insulation a No. 24 B. & S. wire would suffice, this latter wire being desirable.*

Likewise, if the bobbin will contain 1.24 cubic inches of wire, and a resistance of 5000 ohms is required, it is evident that an insulated wire with 4050 ohms per cubic inch would satisfy this condition, and by referring to Fig. 8 it is found that No. 40 B. & S. wire with 1.5-mil silk insulation will meet this requirement.

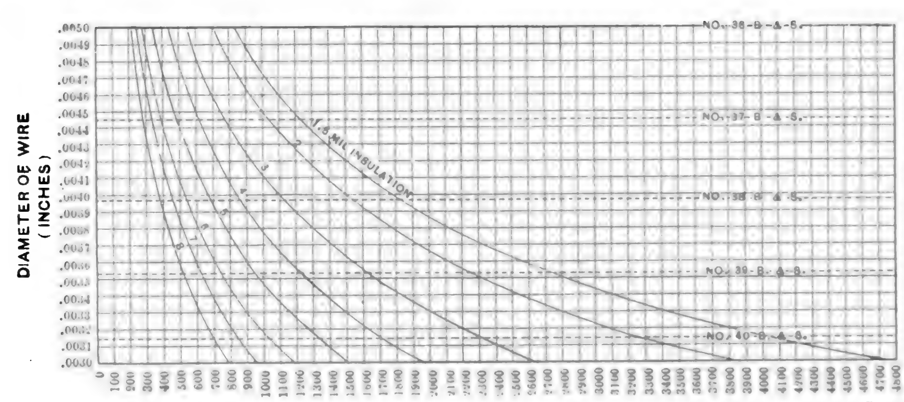

FIG. 8.

The following cases will aid in approximating coils:

Case 1.—Given a bobbin with dimensions $D = 3$, $d = 1.5$, $L = 3.25$, resistance 500 ohms, to find proper size of wire with 4-mil single cotton insulation.

Referring to Fig. 2 it will be found that there will be 5.25 cubic inches per inch of length of winding which makes the volume of the winding $5.25 \times 3.25 = 17.06$ cubic inches. The ohms per cubic inch will then be $500 \div 17.06 = 29.3$. Reference to the charts will show that the nearest copper wire with 4-mil insulation will be No. 29.

Case 2.—If No. 30 B. & S. 4-mil insulated wire were used in the above case and the resistance were 500 ohms as before, what would be the outside diameter of the winding, all other dimensions remaining the same?

Referring to Fig. 6, it will be found that the ohms per cubic inch are approximately 44 for No. 30 B. & S. wire with 4-mil insulation. Therefore, the volume of the winding must be $500 \div 44 = 11.4$ cubic inches, and since the length of the winding is 3.25 inches the winding volume per inch of length will be $11.4 \div 3.25 = 3.5$. Referring now to Fig. 2, and tracing vertically upward from 3.5 to the point where this line intersects the curve which starts from 1.5, the outside diameter, D, is found to be 2.58 inches. Therefore, wind to a diameter of 2.58 inches, with No. 30 B. & S. wire with 4-mil cotton insulation, and the resistance will be approximately 500 ohms.

While other cases may be worked out for any given diameter of wire and any increase due to insulation, the two cases above given are the most used, and after a little practice these problems may be very easily worked out.

* See "Comparison of Common Methods of Coil Windings," AMERICAN ELECTRICIAN, May, 1905.

ELECTRIC CONTRACT WORK.

BY LOUIS J. AUERBACHER.

Wiring System.

Before laying out the wiring system for a building, it is necessary to ascertain whether power will be supplied from the central station, or whether it is the intention of the owners to install a private plant to generate electric power. If the latter plan is decided on, a two-wire multiple system should be installed. Fig. 1 shows the general scheme of such a system in connection with a dynamo.

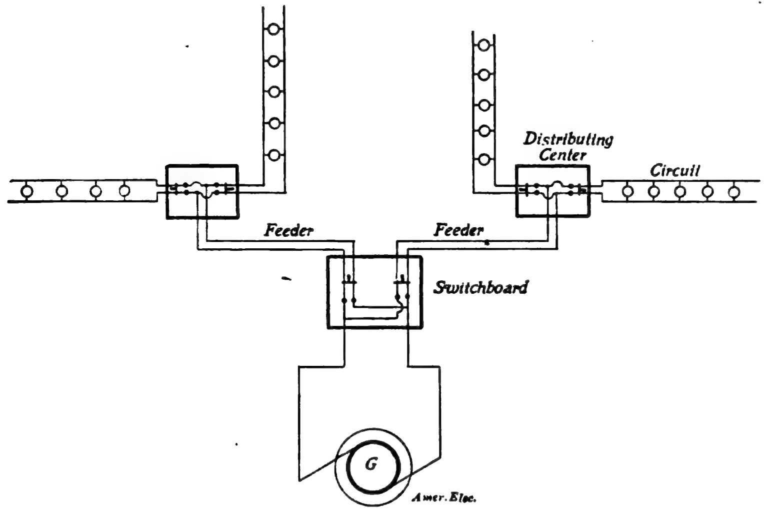

FIG. 1.

Should the local illuminating company supply power as an auxiliary or breakdown service, as it called; this supply should be connected to the wiring system through a double throw switch. This double throw switch can also be used as the generator switch and the method of connection is shown in Fig. 2.

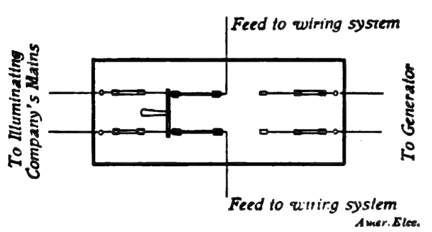

FIG. 2.

Should the auxiliary supply furnished by the local illuminating company, be brought in through a three-wire system, the connection at the switchboard would be made through a double-throw three-pole switch, as shown in Fig. 3. The side of the switch controlling the current from the plant is bridged as shown in the diagram.

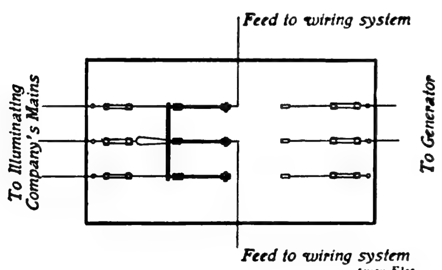

FIG. 3.

Should it be decided to use only the power from the local electric light company, the system in use must be ascertained before the general scheme of wiring is laid out. If a three-wire system is used the general scheme of wiring will be as shown in Fig. 4. When installing this system in a building it is best to put in the three-wire convertible system, or "three-wire two-wire," as it is sometimes called. The only difference between this system and the straight three-wire system is that the center, or neutral, wire of the mains and feeders should have a current capacity equal to the other two. The reason for this is that it allows the system to be readily changed over to a two-wire system for use in connection with a private plant. It sometimes happens that after using power from the local electric illuminating company for some time, conditions arise which make it expedient for the owners to install a private electric plant. If a straight three-wire system had been originally installed, the mains and the feeders when used on a two-wire system would not be heavy enough by 25 per cent., as the neutral wire of a straight three-wire system is the same in size as one of the two outer wires, and theoretically carries one-half the current or less.

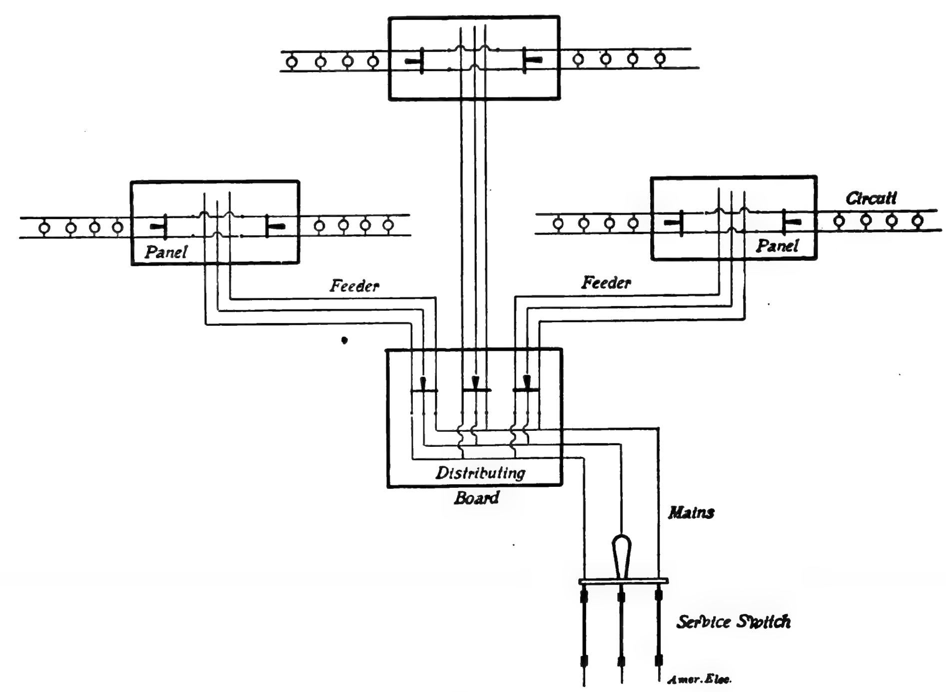

FIG. 4.

To change a regular three-wire system to a two-wire system would be expensive, since it would require the reinforcement of all mains and feeders by an additional wire.

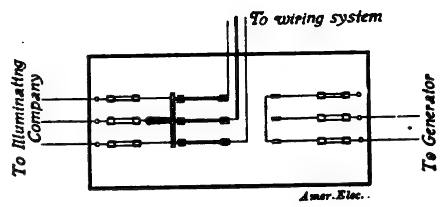

FIG. 5.

This wire would be connected with the neutral wire so as to make the capacity of the neutral equal to the sum of the other two (Fig. 6). On the other hand, if a three-wire two-wire system had been originally installed no change in the wiring system would be necessary. The only change would be at the service end of the switchboard, see Fig. 5, and the doubling of the size of the center fuses. It is, of course, possible to install a plant to operate a three-wire system, but such a plant is more expensive to install than one for a two-wire system, as it is necessary to add a balancer in connection with a 240-volt generator. This balancer set should have one-tenth the capacity of the plant. Such an equipment has its advantages when 240-volt motors and 120-volt lamps are connected to the system. With this plant no changes in the motors are necessary, whereas in a straight 120-volt system the motors would have to be changed from 240 to 120-volt machines.

The supply from the local illuminating company may be two-phase alternating, and if the load to be connected to such a system is small, say not over 10 kilowatts, the general practice is to wire for a straight two-wire system, using one phase of the current for a supply. In larger installations power is taken from both phases and balanced the same as a three-wire system. A

four-wire main, or feeder system can be used (see Fig. 7), in which each set of two wires carries one-half the current, or three wires can be used as in a three-wire system. The difference between the two is that in a three-wire, two-phase system the

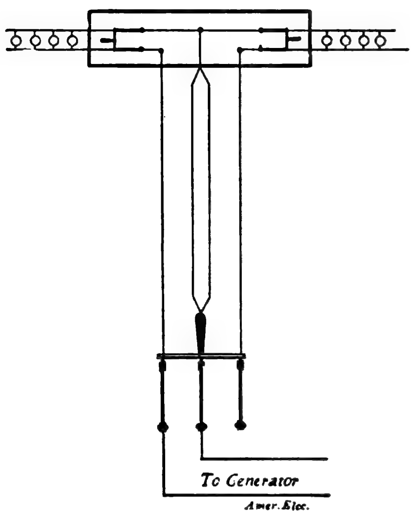

FIG. 6.

central wire should have 1.8 times the capacity of one of the outside wires. It should be always borne in mind that if any alternating system is used in connection with iron pipe or conduit all the wires of a circuit must be placed in one pipe to avoid induction. In a two-phase system the two wires of each phase can be placed in a pipe. This matter is fully covered in the Underwriters' Electric Code.

As soon as a decision is reached as to the particular system to be used, the contractor may lay out the mains, feeders and branches of the wiring system. The outlets are first located and then the distributing centers. There is no fixed rule or plan by which to go, but the current density and source of supply are the main points to be considered in locating these centers. Another point which must be taken into consideration is the construction of the building with relation to runways and shafts, which provide easy runs for feeders.

In Fig. 8 is shown a floor plan of a loft building, in which the outlets are distribut-

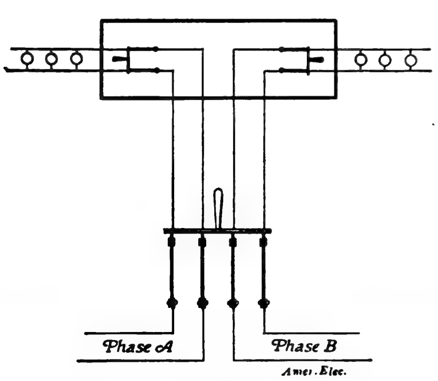

FIG. 7.

ed evenly. The source of supply is in the front of the building, and an elevator shaft is located near by. This shaft is an ideal place for placing the feeders, and the panel is shown near the shaft. In many buildings it is impossible to run the feeders up the shaft, owing to the construction of these. In such cases the feeders are run up the side walls, or in specially built pipe shafts. Feeders and panels should be located at current centers.

Panel-boards in loft buildings or in any building requiring 8 to 10 circuits to a floor should be distributed one to a floor. In private houses it is sometimes advisable to install only one panel for the entire house. This is good practice for a three-story house not requiring over twelve circuits.

In a building covering a large area it is often advisable to install two panels or centers to a floor, with two sets of feeders. It is advisable to keep circuit lengths down to 100 feet or less, and the judicious laying out of circuit centers will save many feet of wiring.

The feeder system for a building depends on many conditions. A good scheme is to draw an elevation of the building (Fig. 9) and note on each floor the current requirements. The best plan is to furnish a feeder for every floor, especially in large installations. In smaller installations one or two feeders are sometimes all that are required. Feeders for motors should be installed independent of the lighting feeders. In the case shown by Fig. 9 it will

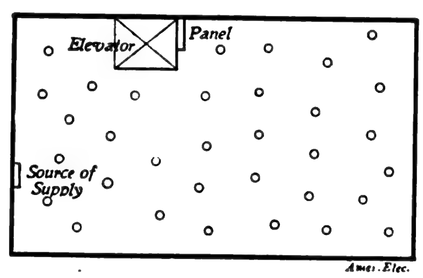

FIG. 8.

be seen that the basement and first floors require the most power. In such a case a feeder is run for these floors, and a sub-feeder from the basement to the first floor. It is not worth while to reduce the size of the sub-feeder unless the amount of current used on the sub-feeder is a small percentage of that used in the feeder. Another reason is that in changing the size of a wire the underwriters require a fuse to be inserted. This makes it necessary to install a larger panel with larger trim, etc., and the consequent expense easily offsets any gain made by installing a smaller wire.

Feeders needing over 2 in. pipe should not be used. It is better to subdivide them, especially if there are many bends or offsets, since two inch pipe is about the limiting size for economical handling.

The feeders should all radiate from a distributing panel, having a proper sized switch and fuse for each feeder. If the system of wiring is such that auxiliary power is taken from a local lighting company it is a good plan to have each circuit controlled by a double-throw switch so that in case of overload any circuit can be fed from the illuminating company's mains (see Fig. 10).

The main wires should start from the illuminating company's service, and these companies have their own requirements as to where the contractor is to wire from. Some companies make the contractor run a line outdoors, furnish switch and fuse and also meter-board and loop. Other companies do not. The contractor can easily ascertain the requirements by

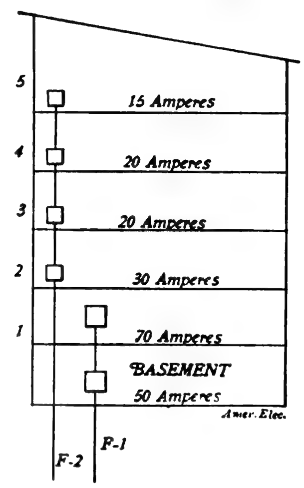

FIG. 9.

consulting the local inspector. The mains should be carefully installed and be of ample size. The contractor should urge his customer to provide for at least 25 per cent. more power than is at present required; and if future requirements are known, in a general way, the wiring for the ultimate load should be installed although the immediate requirements call for a much smaller wire.

The contractor benefits by this surplus, and can more readily obtain orders for additions which would perhaps not be considered if the mains had to be changed at considerable expense.

It is a good plan to run mains and feeders in iron pipe even though the circuit wiring is run otherwise. Since the former carry the main supply of current it is important to have them well protected as they usually run up side walls. The Board of Fire Underwriters make numerous restrictions against open or molding work on

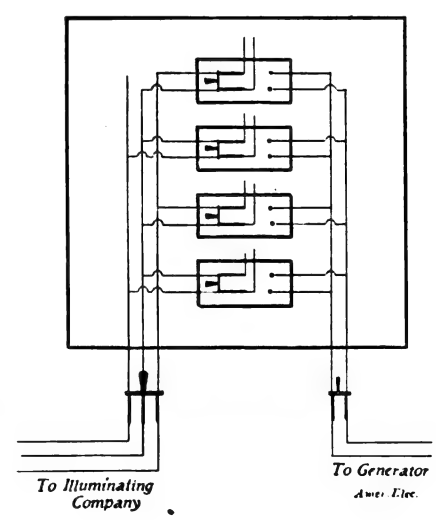

FIG. 10.

brick walls and require good protection, and this is an additional reason for piping the mains and feeders.

In laying out the branch circuit wiring it is not a wise plan to use up the Underwriters' circuit allowance of 660 watts.

Of course it will cost a little more to run ten 16-c.p. lamps or 500 watts to a circuit, but it is good practice. There are always small additional loads thrown on the wiring system and if the circuit capacity is not up to the limit additional outlets may be cheaply installed. From a business standpoint this plan has two sides. One is that the contractor can earn more by installing an extra circuit, while on the other hand the extra expense of running the circuit will often deter a customer from making any changes.

In runs over 100 feet on a 110-volt system No. 12 B. & S. gauge wire should be used, otherwise the drop of potential will

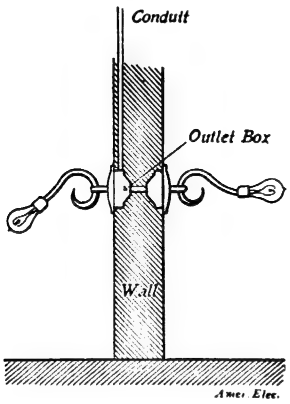

FIG. 11.

be too large. When locating side wall brackets in adjoining rooms these should be placed so that they will come back to back (Fig. 11). This saves much wiring.

In laying out a system of wiring, using moulding or knob and cleat work, the scheme of panels and feeds is the same. The difference is in the wiring appliances, which will be treated in subsequent articles.

In calculating the size of conductors, the following wiring formulæ will be found sufficiently accurate for general purposes:

FOR TWO OR THREE-WIRE, DIRECT-CURRENT LINES.

$$21.62\ D\ I \div v = \textit{cir. mils},$$

D being the distance in feet one way, I the current in amperes, and v the volts lost in the line.

Example.—Required, the size of mains to feed 100 16-c.p. incandescent lamps requiring 0.5 ampere each, the voltage of the circuit being 110, the distance 50 feet and the voltage drop 2 per cent.

$21.62 \times 50 \times 100 \times 0.5 \div (110 \times 0.02) = 24{,}523$ cir. mils = No. 6 B. & S. gauge wire, which is the nearest size.

In a 110-volt, three-wire system (220 volts between the outer wires) the current requirements should be calculated as equal to one-half that of a straight two-wire system. Consequently the three wires will each be one-half the size required on a two-wire system.

FOR ALTERNATING-CURRENT LINES.

$D\ W\ K \div P \times E^2 =$ *cir. mils* of each wire, D being the distance of transmission in feet one way, W the total number of watts to be transmitted, P the per cent loss in the line, E the voltage of the circuit, and K a constant, the various values for which are given in Table I.

TABLE I.

	Values of K				
Power factor	100	95	90	85	80
Single-phase	2160	2400	2660	3000	3380
2-ph. (four wire).	1080	1200	1330	1500	1690
3-ph. (three wire).	1080	1200	1330	1500	1690

Example.—What size of conductor will be required to transmit 100 amperes a distance of 50 feet on a two-phase system at a loss of 5 per cent, the voltage of the circuit being 110 and the power factor 90?

$100 \times 110 \times 50 \times 1330 \div (5 \times 110^2) =$ 12,091 *cir. mils* = No. 8 B. & S. wire, size of each wire.

In all calculations for the size of wire the Underwriters' requirements must be adhered to, so that if the calculated size for certain conductors is smaller than that allowed by the Board of Fire Underwriters, the size of wire given in the Code must be used.

Abstracts from Foreign Contemporaries

"Oriflame" Arc Lamp.– The chief difficulty with which makers and users of flame arc lamps have had to contend, is the rapid consumption of the carbon, so that the choice hitherto has been between comparatively short burning hours, or the employment of abnormally long carbons. In the "Oriflame" lamp, shown by Fig. 1 herewith and described in the London *Electrician*, the difficulty is overcome by the employment of a magazine capable of

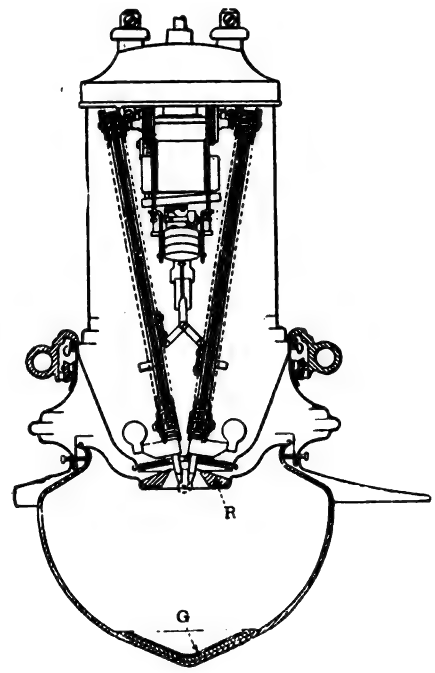

FIG. 1.—"ORIFLAME" ARC LAMP.

holding nine pairs of carbons each 12 inches long. These are of exceptionally small diameter; but the proportion of the total section taken up by the core is greater than in ordinary flame arc lamps. It has been found that within certain limits the greater the relative size of the flame-producing core, the greater the efficiency of the arc; but unfortunately the carbon is also more rapidly consumed. As, however, the lamp has a magazine to draw from, the carbons may be burned at a high rate and the arc is supplied with the requisite amount of potassium silicate and calcium fluoride, which produce flame and color respectively. Since the carbons are of smaller size, it is possible to use carbon of comparatively poor quality without impairing the steadiness of the arc. The cost of carbons need not therefore exceed one-fifth of a cent per lamp-hour in a nine-ampere lamp. Each pair of carbons burns five hours. The carbons are placed in two flat boxes inclined at an angle of 22 deg. They are put in at the back and are pressed forward by a pair of arms controlled by a spiral spring. Fig. 3 shows one of the magazines, the arms, *A A*, pressing against the carbons, *C*. The front carbon is forced from the magazine as shown, and is pressed forward by the stud, *S*, fixed on a chain, *B*. It is this chain which feeds the lamp. As shown, the stud, *S*, presses down the carbon as the lamp feeds by the travel of the chain. When this stud reaches the bottom the carbon is ejected and the next one takes its place, being pressed down as the chain travels by a second stud, *T*. One of the magazines is pivoted on the crown of the lamp, and this is swung by the controlling electromagnet to strike the arc, and also serves to regulate the length of the arc. When it reaches its extreme position, it closes an iridium

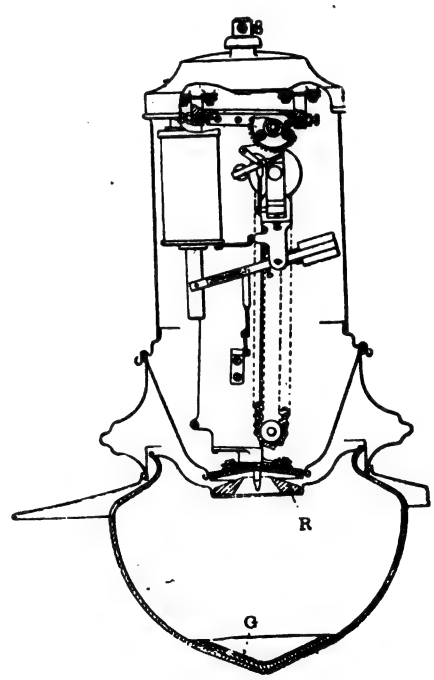

FIG. 2.—"ORIFLAME" ARC LAMP.

contact and sets into operation a make-and-break mechanism which actuates the sprocket wheels and feeds the chain onwards. The chain and rocking lever are mounted on knife edges so as to minimize

friction. The general arrangement of the lamp is shown by the engravings. The reflector, *R*, is provided to prevent the deposit of the products of combustion on the globe of the lamp. The reflector is made

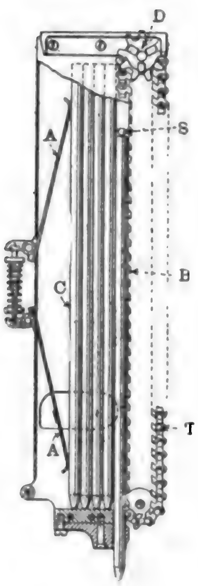

FIG. 3.

of porcelain in a copper spinning, and rests on the rim of the globe on three distance pieces. By this arrangement there is said to be an upward draught of air through the hole in the reflector and the products of combustion are deposited above. An ash tray, G, catches the short ends of carbons. The angle between the carbons is so small that no blow-out magnet is necessary. The voltage of the arc is 35, and allowing 5 volts for steadying resistance, etc., this represents 360 watts per lamp, the standard lamp consuming 9 amperes. The maker maintains that the light is far more intense than that given by the ordinary 500-watt lamp.

Tests of Tantalum Lamps.—Some interesting life and efficiency tests of tantalum lamps have recently been published by Prof. W. Wedding in the *Elektrotechnische Zeitschrift.* Fig. 1 indicates the distribution of light of the 25-c.p., 110-volt

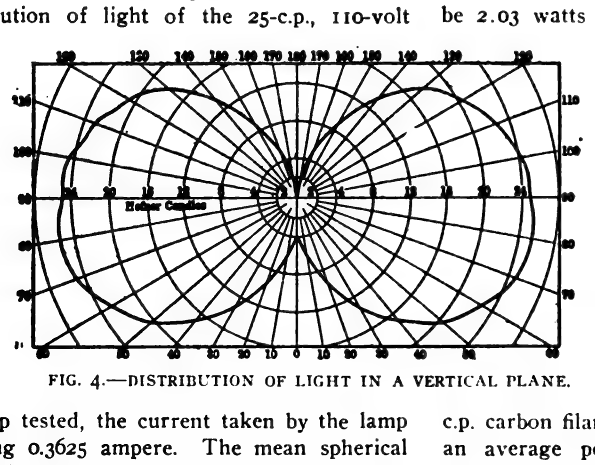

FIG. 4.—DISTRIBUTION OF LIGHT IN A VERTICAL PLANE.

lamp tested, the current taken by the lamp being 0.3625 ampere. The mean spherical candle-power was found to be 19.3 Hefner candles, so that the consumption per mean spherical candle-power works out at 2.065 watts, the consumption per candle-power in the horizontal plane being 1.6 watts. As regards the absolute efficiency of the lamp, the author calculates it to be less than 1 per cent, 0.866 of 1 per cent to be exact. Four new 25-c.p. lamps were tested until they collapsed. At the same time four ordinary filament lamps of 25 candle-power and 16 candle-power respectively were tested in the same manner. The average results are shown in Fig. 5, the four small crosses indicating the first breakage of filament in each of the tantalum lamps.

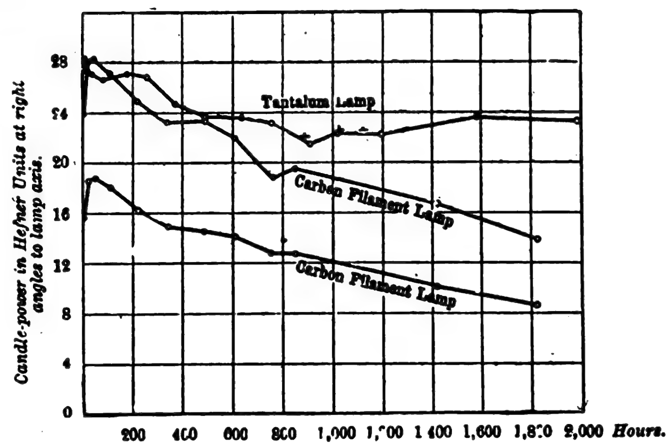

FIG. 5.—CURVES SHOWING THE VARIATION OF CANDLE-POWER WITH THE TIME.

As is well known, a breakage of the tantalum filament does not necessarily terminate the lamp's life; on the contrary, the broken ends generally make contact with some part or other of the filament, and the lamp continues to burn. But the breakages afterwards generally occur at shorter and shorter intervals, until the lamp becomes useless (see Fig. 6). At the commencement of the tests the average consumption of the four tantalum lamps per candle-power at right angles to the lamp axis was 1.68 watts. This figure dropped to 1.57 watts after seven hours and then rose to 1.60 watts after 17 hours, 1.62 watts after 37 hours, 1.67 watts after 85 hours, 1.64 watts after 179 hours, 1.66 watts after 256 hours, 1.79 watts after 370 hours, 1.89 watts after 637 hours, 2.04 watts after 905 hours, and 1.94 watts after 1,582 hours. The power consumption of the last lamp which survived, measured after 1,989 hours of burning, was found to be 2.03 watts per candle-power. The 25-

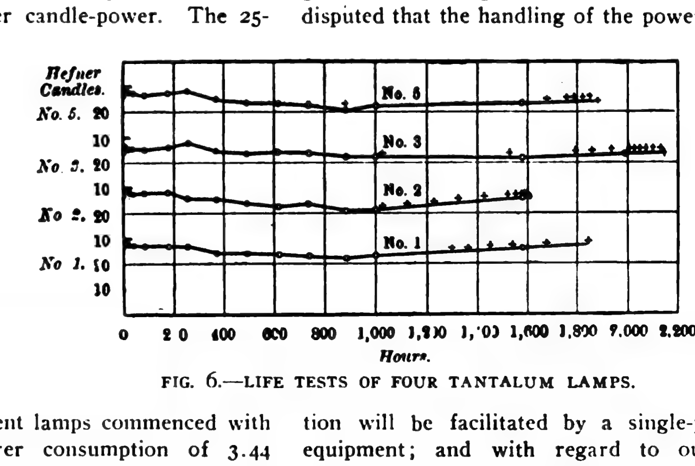

FIG. 6.—LIFE TESTS OF FOUR TANTALUM LAMPS.

c.p. carbon filament lamps commenced with an average power consumption of 3.44 watts. After 21½ hours this figure had dropped to 2.79 watts, after 110 hours to 2.94 watts, after 344 hours to 3.36 watts, after 609 hours to 3.52 watts, after 850 hours to 3.85 watts, after 1420 hours to 4.38 watts, and after 1826 hours, finally, to 5.25 watts. Similar figures were obtained for the 16-c.p. lamp—viz.: 3.23 watts per candle-power at the start, 2.81 after 21½ hours, and 5.44 after 1826 hours.

Single-Phase vs. Polyphase Transmission Lines.—H. S. Watson contributes to the London *Electrician* a short article on this subect. In spite of the great success of three-phase alternating-current systems, signs are not wanting that electrical engineering opinion may yet return to the almost discarded single-phase system. The advocates of single-phase have conceded to the three-phase system a saving of 25 per cent in the copper of the transmission lines; and it is to this supposed disadvantage of the single-phase system that the author draws attention. The relative copper efficiency depends entirely on the point of view from which the question is looked at. If a 10,000-volt single-phase system is compared with a three-phase system having the same voltage between its lines, the latter system, of course, has the lower copper cost for the same efficiency. But this is not a fair basis of comparison when an overhead line is in question. The basis of comparison should be that the insulation between any one line and earth shall be the same. The insulators are the determining factor. The author shows mathematically that on this basis an equal power can be transmitted with the same efficiency over a single-phase as over a three-phase system if the weight of copper is the same. It becomes a question with the author whether with overhead transmission it is better to erect a single-phase or a three-phase installation; and it would appear that there is some point at which the first cost in the two cases is equal. This point will depend on the distance of transmission, and must be determined by the following considerations: On the one hand, the prime cost of single-phase generators is higher than that of three-phase generators. On the other, there must be considered the cheaper switchboard, fewer insulators and 33 per cent. less labor required in erection of the overhead bare cable. As regards the running costs, it will hardly be disputed that the handling of the power station will be facilitated by a single-phase equipment; and with regard to outside maintenance, there would be only two lines to look after instead of three.

Testing Earth Connections.—H. Corsepius contributes to the *Elektrotechnische Zeitschrift* an article on earth connections. As is well known, the frames of electric ma-

chines are often grounded for safety's sake. The purpose of the earth connection is to make sure that any currents which may pass from the frame, etc., to earth will pass through the earth connection and not through a person who may be in contact with the frame. If such earth connections shall be effective, it is necessary to keep them in good order and to test them regularly. The author points out that tests made with small voltages, such as used with the testing bridge and the telephone, are not so reliable as tests made with higher voltages. In the case of an alternating-current installation, the author recommends to use the supply current itself for testing, of course, through the intermediary of the transformer, while for direct-current testing a small storage battery is used. Two different connections are shown for testing, one for direct-current testing and the other for both direct and alternating-current testing. By his method he has found the following values: An earth connection consisting of a large 1 by 1.5 meter sheet iron plate with a copper cable, screwed and soldered to it at various places, had a resistance of about 7 ohms. Wire used as earth connections, as is often done with lightning rods, had a resistance of about 50 ohms. Lead pipes, of 20 mm. external diameter, 10 meters long and embedded in a trench 1.2 meters deep, showed resistances of about 6.5 to 8.5 ohms, and are considered by the author as quite advantageous. Underground pipes which belong to a large network, such as water pipes and gas pipes, have a very low resistance.

Three-Phase Motors Operated from Single-Phase Mains.—J. Dalemont, in a recent number of the *Elektrotechnische Zeitschrift* shows how three-phase motors may be operated from single-phase mains with the aid of inductance and capacity. Fig. 7 shows the diagram of connections, in which *I, II, III* are the windings of an ordinary three-phase motor, *C* a condenser, *R* an inductance, and *A B*, single-phase mains. It will be noted that the phase, *I*, is connected in a reverse direction to the ordinary. The author gives the results of some experiments made with a one horse-power single-phase motor running at a speed of 1,500 r.p.m. The motor was first supplied from a three-phase circuit and tests were then made with the same motor on single-phase mains, the connections being as shown in Fig. 7 with the exception that phase *I*

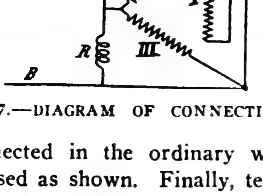

FIG. 7.—DIAGRAM OF CONNECTIONS.

was connected in the ordinary way, and not reversed as shown. Finally, tests were made with the motor connected as shown in Fig. 7, and the results of the tests are plotted in Fig. 8. The author points out that the motor may be thus operated successfully for continuous running. He also calls attention to the high value of the power-factor, and thinks that it would be

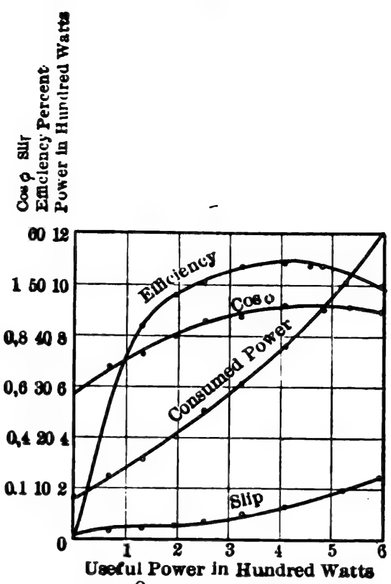

FIG. 8.—TEST CURVES.

possible to use three-phase motors in the manner described for traction purposes, only one overhead conductor being required.

Some Recent Electrical Patents

Switch for Heavy Currents.—A patent was issued recently to Mr. Frank Conrad and Mr. Arthur B. Reynolds, covering a

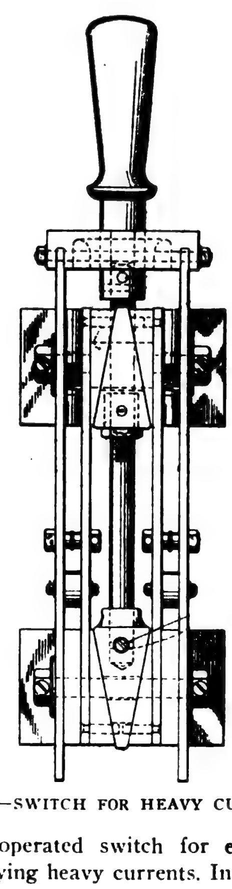

FIG. 1.—SWITCH FOR HEAVY CURRENTS.

manually-operated switch for electric circuits carrying heavy currents. In the single-pole switch shown in Fig. 1, at each terminal there are two stationary and four movable contact members. The handle which is provided for opening and closing the switch is rigidly attached to a rod upon which are properly mounted two wedges which move longitudinally when the handle is rotated. Each wedge is located between two blocks which serve to press against the switch blades when the wedge is moved in the proper direction. The wedges are provided in order that adjustment of the contact-terminals may be made after the switch is closed so as to increase the intimacy of contact between the movable and stationary contact members. By turning the handle, the parts may be loosened when it is desired to open the switch. Patent No. 803,212.

Rheostat.—The accompanying illustration shows a rheostat which formed the basis for a patent issued recently to Mr. George E. Stevens, of Lynn, Mass. The resistance unit consists of one or more

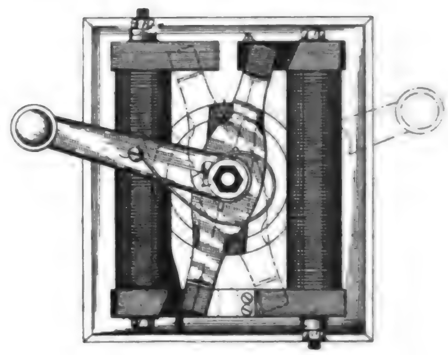

FIG. 2.—RHEOSTAT.

helical edgewise-wound resistance ribbons having their turns held in place by a cement which serves not only to insulate the turns but also to bind them together. The fixed element of the rheostat consists of two such units arranged parallel to each other and firmly secured to end blocks by means of bolts which extend through the interior of the units and through suitable apertures in the blocks. A rotary contact is mounted so as to rotate about a central post located midway between the resistance units and extending transversely thereto. As the operating handle is moved, the contact progressively engages the turns of the resistance winding. A spiral spring is provided for the purpose of returning the parts to the "off" position. A locking-magnet, the coil of which receives current through the field circuit, serves for holding the rotary contact in the position in which all of the resistance of the rheostat is short-circuited. Patent No. 803,452.

NOTES.

Electric Heating.—Mr. James I. Ayer has been appointed by President Blood, of the National Electric Light Association, to report on the Progress of Electric Heating at the next convention of the association.

Sale of Light and Power.—Mr. A. F. Sheldon, president of the Sheldon School of Scientific Salesmanship, delivered a lecture before the selling and canvassing force of the New York Edison Company on the sale of electric light and power. The lecture was well attended and illustrates the further adoption of progressive ideas by the New York Edison Company.

Rates and Costs.—The Committee on Rates and Costs, which made its report to the Denver Convention of the National Electric Light Association, has been reappointed by President Blood. The committee consists of Messrs. Charles L. Edgar, chairman; Louis A. Ferguson, Samuel Scovil, Frank W. Frueauff, P. G. Gossler and R. S. Hale. Mr. George W. Brine declined to serve again this year on account of ill health.

Lights on Transmission Towers.—The Niagara, Lockport & Ontario Power Company has decided to place electric lights on each of its transmission towers extending from the Devil's Hole near Niagara through Buffalo and Rochester to Syracuse. The plan is to surmount each tower with three lights, red, white and blue in color, which will be lighted during the summer months only, as the work of renewing the lights in cold weather would be too great.

Vermont Electrical Association.—The third annual convention of the Vermont Electrical Association was held at the Berwick House, Rutland, on October 25. The following officers were elected: President, E. E. Gaige, of St. Johnsbury; first vice-president, George E. Haley, of Rutland; second vice-president, E. E. Larrabee, of Bennington; secretary and treasurer, C. C. Wells, of Middlebury. Executive Committee—Frank Barney Jr., of Springfield; Frank Collins, of White River Junction; J. E. Davidson, of Montpelier; F. H. Parker, of Burlington, and E. D. Blackwell, of Brandon.

American Society of Mechanical Engineers.—The 52d meeting of the American Society of Mechanical Engineers will be held in New York City during the first week in December. The headquarters will be at the Edison Auditorium, 44 West 27th Street. The opening session, at which President John R. Freeman will deliver the annual address, will be held on Tuesday evening, December 5. The business session will be held next morning in the main saloon of the steamship *Amerika* at the docks of the Hamburg-American Line, Hoboken, N. J. Following this session, a special train will take those desiring to make the excursion to the Worthington works at Harrison, N. J. There will be an illustrated lecture by Professor R. W. Wood at the Edison Auditorium on Wednesday evening. The third session will be held on Thursday morning, and besides the presentation of professional papers there will be a discussion on the subject of "Bearings." In the afternoon there will be a reception at the New York School of Automobile Engineers, 146 West 56th Street. The usual reception at Sherry's will occur on Thursday evening. The closing session will be held on Friday morning and will be devoted to the presentation of professional papers.

CENTRAL STATION ENGINEERS.—XIV.

Walter L. Mulligan.

Walter L. Mulligan, manager of the United Electric Light Company, of Springfield, Mass., was born July 6, 1875, at Springfield, Mass. He acquired his early education in the public schools of his native city and afterwards entered Cornell University. He left the university at Ithaca in 1897 and entered the employ of the United Electric Light Company, of Springfield, as an electrician. Diligence and aptitude for business soon met with the approval of his superiors, for step by step he was promoted from one department to another, until in 1900 he was appointed assistant manager of the company. His broad knowledge in the field of electric lighting gained through service in almost

WALTER L. MULLIGAN.

every branch of the work, enabled him to perform the duties of this office with such efficiency that in 1902 he was offered the position of manager, which post he still holds.

New York Electrical Society Lectures.—Among the lectures scheduled by the New York Electrical Society for the season 1905-06 are the following: "Wireless Telegraphy," by William Marconi; "Electrification of the Long Island Railroad," by O. S. Lyford, Jr.; "Newspapers and the Telegraphic Art," by Melville E. Stone; "The Turbine," by C. G. Curtis; "The Place of the Electric Vehicle in Automobilism," by Robert McAllister Lloyd; "Single-Phase Railway Work," by C. F. Scott, and "The Block Signal System on the Subway," by J. M. Waldron.

Preserving Niagara Falls.—It is announced that Secretary Root will shortly open negotiations with the British Government for the purpose of reaching an agreement for the preservation of Niagara Falls from further utilization and to protect the scenic beauty of the spot.

The Chicago Electrical Trades Exposition.—Mention has already been made in these columns of the formation in Chicago of the Electrical Trades Exposition Company to hold an electrical show in that city the coming winter. The company has as officers and directors a number of prominent men in the electrical trade and central station work in Chicago. A circular has just been sent out announcing the plans in detail and giving plans of the exhibit space at the Coliseum, where the show is to be held. It will begin at 7 p. m. Monday, January 15, and continue until 10.30 p. m. Saturday, January 27, 1906. It will be open daily, except Sunday, from 10 a. m. until 10.30 p. m. Rental charges for exhibit space will be $1 per square foot on the main floor, and 50 cents per square foot in the balconies and galleries. Probably the conventions of at least three electrical organizations will be held during the time of the show, and exhibits made at this show will serve all the purposes of exhibits made at these conventions. Much interest is being displayed. The general manager is Thomas R. Mercein, secretary of the Northwestern Electrical Association, whose office is now 464 Monadnock Building, Chicago.

A Point for the Central Station Man.—Progressive central station men throughout the country are to-day greatly interested in methods of securing new business and large sums of money are expected each month with this object in view. The variety of ways in which the public can be interested in central station service is innumerable, but it is not always appreciated that many of the most effective texts for newspaper and other advertisements may be drawn from very ordinary sources. For example, it is widely the custom of dealers in bric-a-brac and crockery to use the incandescent lamp in displaying all kinds of ornamental lamp shades, rather than to light up the shades by gas or oil. Here is a plain confession on the part of the retail merchant that electricity is the cleanest, safest, most flexible and most artistic illuminating agent known to civilization, and the central station man who seizes upon such pointed and palpable illustrations of the superiority and attractiveness of his product may well turn his action to profitable advantage. There is a real bit of humor in selling gas or oil lamps through the agency of electricity—which lights such merchandise better than the illuminants for which the lamps were originally designed.

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THE AMERICAN ELECTRICIAN *has the largest circulation of any electrical journal published. Of this issue, 17,000 copies are printed. The total number of copies printed so far this year is 215,000, or an average of 17,917 per issue.*

CONTENTS.

To Our Readers:

With this issue the AMERICAN ELECTRICIAN ceases to exist as a separate publication, and beginning with the new year will be consolidated with the *Electrical World and Engineer,* the combined journals to be henceforth known as the ELECTRICAL WORLD. The *Electrical World and Engineer* dates from *The Operator,* founded in 1874. It became a weekly publication in the pioneer period of modern electrical development under the name to which it will shortly return; in 1899 consolidated with it the weekly *Electrical Engineer,* and during its long history has always and everywhere been recognized as the leading weekly electrical journal of the world.

The consolidation of the two journals does not, however, involve any sacrifice of the interests of the great body of readers whose encouragement and support have enabled the AMERICAN ELECTRICIAN to attain and hold the enviable position it has for the past ten years occupied in the field of electrical journalism. The monthly journal will, in fact, be continued as the first issue of the month of the ELECTRICAL WORLD, these twelve particular issues of a year being subject to a separate subscription of $1.00 per annum. All subscribers of this journal will receive this issue during the unexpired terms of their subscription. While retaining the features of the monthly to which it succeeds, this issue will also incorporate the practical features of the ELECTRICAL WORLD, the monthly reader thus being specifically served as in the past, but with an addition of reading matter that will greatly enhance to him the value of the journal without increasing its cost. The present editorial organization of the AMERICAN ELECTRICIAN will be continued and supplemented by the resources of the older weekly in gathering editorial material.

By this concentration of thought and effort heretofore spread over two great technical journals, it is believed that electrical readers of all classes will be served in a higher degree and more completely than has been possible in the past. As involving one of the most prosperous journalistic properties in this country, the step here announced was naturally decided upon only after the most careful thought on every consideration incidental to such a departure from the past methods of electrical journalism. That it will lead to a new record in this field of journalism the great resources of the combined publication assure; and that the loyalty to the AMERICAN ELECTRICIAN which has always so markedly characterized its readers and which in the past has been so great an inspiration in its conduct, may be transferred to its successor, is an ambition toward whose realization no effort will be spared, no stone left unturned.

Zinc in Storage Batteries.

In the early days of electrical science, before the invention of the dynamo, zinc was the electrical metal *par excellence.* Current was supplied by batteries which had a zinc plate as anode, whatever their construction in other respects. The advantage of zinc is to be found in its comparatively high energy of reaction, which results in a comparatively high voltage for zinc cells. In almost all cases in which zinc has been used in batteries it forms a soluble zinc salt which passes into the electrolyte during discharge. This means that the anode disintegrates and must be replaced by a new zinc plate, while there is considerable trouble in winning back the zinc from the solution. The chief disadvantage of zinc primary cells is the high price of zinc. In these cells zinc acts as the fuel, so to speak, and while the efficiency of the generation of electrical energy in the cell is high yet the fuel is very expensive.

The question naturally arises, why not try to use zinc in a secondary or storage battery? In this case after the cell has been discharged a current is sent through it in the opposite direction with the expectation that the chemical reactions during discharge would be exactly reversed. This is theoretically correct and in practice the reverse chemical reactions take place to a certain extent. However, there are two inherent disadvantages. There is, first, the difficulty of depositing the zinc back on the zinc plates in coherent dense form; secondly, the electrolyte will consist of a mixture of the zinc salt with free acid and when the charging begins the current has a tendency to decompose the acid instead of the zinc salt. While some zinc will be deposited, the main action will be the liberation of hydrogen; which means, of course, waste of current. It is for this reason that the lead-zinc storage battery, although it has given

comparatively good results in the laboratory, has proven a failure in practice.

The main advantage which the zinc-lead cell has over the ordinary lead cell is the higher voltage due to the higher energy of the reaction of zinc compared with the reaction of spongy lead. This higher voltage would undoubtedly be a great advantage, for instance, in automobile work. In this connection the new German zinc-lead cell described in this issue by Dr. Gradenwitz is interesting; but it is very doubtful whether under the severe conditions of automobile practice the cell will fulfill what its tests in the laboratory have promised. The inventor seems to suspect such troubles since he also provides for the use of the cell as a primary battery. If the zinc plates are thick enough, they will stand several discharges; and after one discharge it will be sufficient to replace the discharged lead peroxide plates by fresh ones and the solution by fresh acid. This is, of course, possible, but the cost of recharging the battery is not avoided. The only difference is that the lead peroxide plates are recharged and the solution is to be regenerated outside of the batteries. This simply adds the cost of handling the plates and acid to the cost of recharging. In practice two possibilities are open; either stations must be provided all over the country to perform the regeneration and always have fresh plates and fresh acid on hand, or the automobile has to carry these with it. In either case, it is difficult to see how the system can be a commercial success.

Broad Economy of Electric Heating.

Every central station manager who is alive to new business possibilities ought to understand thoroughly the broad economy of electric heating and press it home to the community which he serves. In many cases the idea prevails that electric heating is too expensive in comparison with coal and gas to warrant special efforts to sell power for that purpose. The station manager feels that he cannot show any financial saving to the consumer in large propositions and naturally turns his attention to the extension of the lighting and motor loads which offer more immediate and larger profits. These managers fail to realize that operating cost is but a single factor in the heating problem, and is not at all comparable to the immense advantage gained in educating any community to the point of appreciating the universal applicability of electricity to the affairs of civilized life.

The actual money paid for electric heating service is but a poor index of the value received. It is cheaper to walk five miles than to ride the same distance in a trolley car, so far as actual money expended is concerned, and a house may be lighted at less expense with candles and kerosene oil than it can be illuminated with gas or electricity. However, no person whose time is of any value whatever would think of making a five-mile journey afoot, and few householders to-day reject both gas and electricity for candles and oil if a central station circuit is available in the neighborhood. The same reasoning applies to electric heating. Its advantages are so much greater than those of other methods that unless the heating problem is a matter of large volume rather than a question of definite area, the broad economy of operation will lie with electricity. The required work can be done with absolute cleanliness; the power may be switched off the instant the heating process is over, and most important of all, the heat is concentrated exactly where it is needed. With gas or coal as fuel, about 80 per cent. of the energy is wasted, while with electricity about 80 per cent. or over is utilized.

These points are well known to electrical engineers and to consumers of electric heat, but they are still far from being appreciated by the general public. It, therefore, devolves upon the central station manager to keep the public constantly aware of the multiplying applications of electricity in heating service. The list of appliances now on the market covers an enormous range and almost any device specified can be promptly supplied; yet there are many towns where the central station manager has never exhibited an assortment of electric heating apparatus for the purpose of acquainting the public with what is being done in this interesting and essentially domestic field. A small heating load will not add much to the revenue of a central station, but if the thousands of consumers of electricity could be made to realize the exact field in which electric heating is supreme, central station managers would in the long run receive ample benefit.

The Steam Turbine and the Isolated Plant.

Recent developments in steam turbine design indicate that a wider field of usefulness has opened for these interesting prime movers. For some reason the adoption of turbines in isolated plant work has been rather slow in this country, but with the production of large direct-current units the outlook for more extended applications is much improved. Isolated plant practice covers a vast range of service, and the distances of transmission are almost always so short in comparison with those encountered in central station and traction work that direct current is probably used for the bulk of isolated plant loads at the present time. This preponderance of direct-current equipment naturally demands direct-current turbo-generators, and until quite recently the difficulties of commutation, balancing and armature construction for high peripheral speeds have proved serious obstacles in the way of direct-current turbine practice.

A large number of turbo-generators, made up of dynamos geared to their respective prime movers, is in use to-day, and although these machines have not been applied in very large capacities there seems to be no doubt that they are well adapted to the requirements of isolated plant service with either direct or alternating-current distribution. The production of gearless units broadens the field still more and paves the way toward the utilization of those special advantages which particularly recommend the steam turbine to installations where space is limited and loads extremely variable. The uniform angular velocity and freedom from vibration which characterize the steam turbine adapt it particularly to the use of hotel and apartment house plants, where noiseless operation is a desirable feature. The operating simplicity of the turbine is of special advantage in office building work, where a large part of the attendant's time is taken up in maintaining the heating system, piping and elevators in proper condition. With turbo-generators the necessity of stopping and starting various units to secure low steam consumption with load variations is of much less importance than in the case of the reciprocating engine. The foundations required in turbine practice are much less extensive than those needed in the same capacities of reciprocating engines, and the time required for installation is generally less as well. The regulation of small steam turbines is now well within two per cent from no load to full load, which means that the exacting conditions of office lighting can readily be met. The stimulus recently imparted by the manufacturers to the street railway power house market through the development of large direct-current units will doubtless lead to the extended use of turbine units in the isolated plant field, although the extinction of the reciprocating engine is not in the least probable.

DESIGN OF A BATTERY MOTOR.

BY CLARENCE W. COLEMAN.

The motor here described was designed by the writer for operating railroad semaphore signals, although its use is by no means restricted to this class of work. The armature of the motor is entirely enclosed in order to prevent dirt or frost from collecting on the commutator, since either of these would have a tendency to insulate the brushes from the commutator and militate against the reliable operation of the motor. Inasmuch as the motors are intended to operate from potash batteries, it is important that they be very efficient; but reliability of operation is of vastly more importance, and for this reason two sets of copper brushes are used. A brake is provided for the purpose of stopping the motor as soon as the power is cut off. The field magnets when energized attract the brake armature and lift the shoe from the brake wheel, and when they are de-energized a spring applies the brake shoe to the wheel. This is not necessary, but it is found desirable to prevent the mechanism drifting by its latch for the succeeding operation, which would necessitate the running of the motor for a longer period in order to bring the latch around again to operate the signal.

Fig. 1 is a side elevation of the complete motor, and Fig. 2 is an end elevation, looking at the commutator end. Fig. 4 is a cross-section between the pole pieces. Fig. 5 is a bottom view of one of the field magnets, and Fig. 6 is a side view of a field magnet ready for winding. The field magnets are built up of punchings, of which the yoke forms a part, and one-half the punchings in each field magnet has the yoke ¼ inch longer than the other half. The field magnets are built up with two long and two short parts alternately, as shown in Fig. 5, so that when they are put together they form a lap joint. When the proper number of punchings are assembled to make the desired width of field magnet, in this case 2¼ inches, they are clamped in a vice, and brass magnet heads, made in two pieces with a dove-tail tongue on one end and a corresponding groove on the other end, are put on so that the tongue in each end is pressed into the corresponding groove, as shown in Fig. 5; this holds the field magnets in shape for winding.

It is advisable to file the sharp corners of the punchings before putting on the insulation. Fibre heads should be placed next to the brass heads, and two layers of fibre 1/64 inch thick should be wrapped on the core.

The yoke should be clamped in a four-jaw chuck on a lathe and the winding put on. Both field coils should be made alike, and the inside ends of the windings should be soldered together. Each one of the coils should have 220 turns of No. 11 magnet wire. After the field magnets are wound they are put together with a strap on each side, as shown in section by Fig. 4, with a screw through each side of the center, and are then clamped. The field clamps, Figs. 7 and 11, should now be attached, the punchings being held against the extensions of the clamps which fill the space between the poles, and the screws drawn up to hold the parts in place. The field magnets should then be put in the cast-iron base and the wedges driven in so as to hold the magnets in place and force the ends of the punchings together.

The field clamps have the surfaces which bear against the field magnets and the edges of the extensions which go between th poles, finished true, and the inside is bored out true also. The ends of the extensions are finished so one fits into the other about ¼ inch, as shown in Fig. 4. This makes practically one piece of the two clamps and holds them in line with each other, prevent-

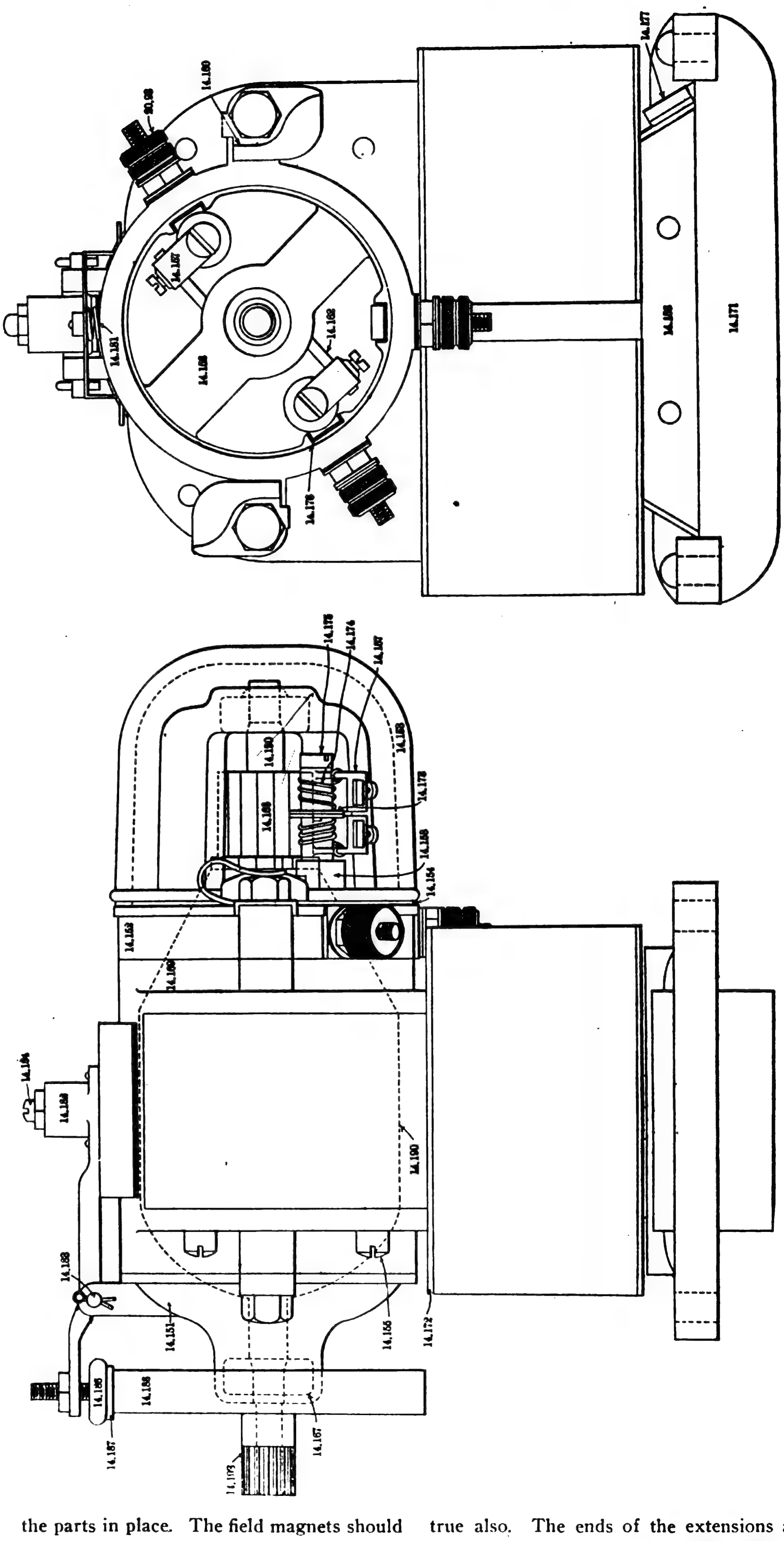


FIG. 1.—FRONT AND SIDE ELEVATIONS OF BATTERY MOTOR.—FIG. 2.

ing the punchings standing on an angle when clamped between them. The extensions on the field clamps fill the space between the pole pieces in order to enclose the armature, and they also form an abutment for the pole pieces so that these cannot be forced against the armature. The field clamps are finished on the outside where the bearing supports come against them. The field magnet laminations are the most difficult parts to make unless one has a punch and die, and the writer has found it cheaper to make a punch and die for this purpose than to machine them. A cheap die can be cut in ¼-in. sheet tool steel, and fastened on a heavy cast-iron base with an opening to let the punchings through. The punch can be made of the same material, mounted on a cast-iron head. It is not necessary to harden these to punch enough pieces for one or two motors, if thin material is used.

The punch and die should be made for the long yoke piece and ¼ inch cut off half of the punchings for the short yoke piece. With the one joint between the fields lapped, and the ends butted together, besides being wedged in a cast-iron base, the magnetic loss on account of joints is reduced to a minimum. Fig. 3 shows a cross-section of the armature and commutator mounted on the shaft. The armature discs shown in Fig. 8 are made of refined sheet iron .015 inch thick and dipped in shellac which is allowed to drain off. For convenience in assembling the armature core discs a brass tube, shown in section on the shaft, is placed on a heavy metal disc having openings to correspond to those in the armature discs, and a bolt passed through both. A fibre disc is now put on, followed by enough armature discs to give the required core length (in this motor, 2¼ inches) when drawn tightly together; then a fibre disc and finally a heavy metal disc are put on. The nut is placed on the bolt and screwed up tight, thus drawing the discs together. The fibre insulations are put in the arma-

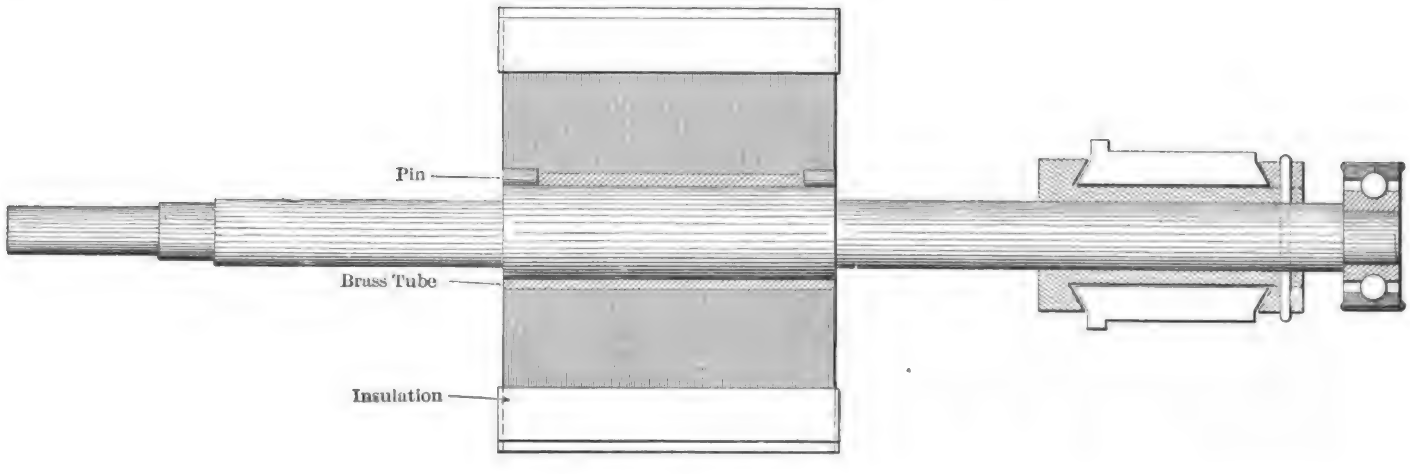


FIG. 3.—SHAFT, ARMATURE AND COMMUTATOR.

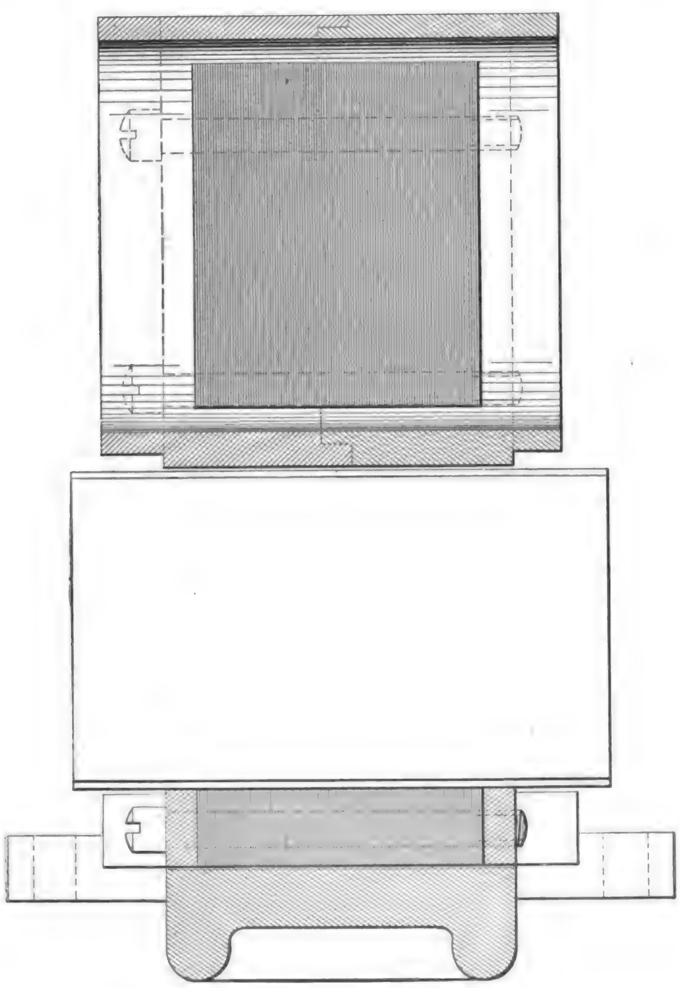


FIG. 4.—SECTIONAL END VIEW OF FIELD MAGNETS.

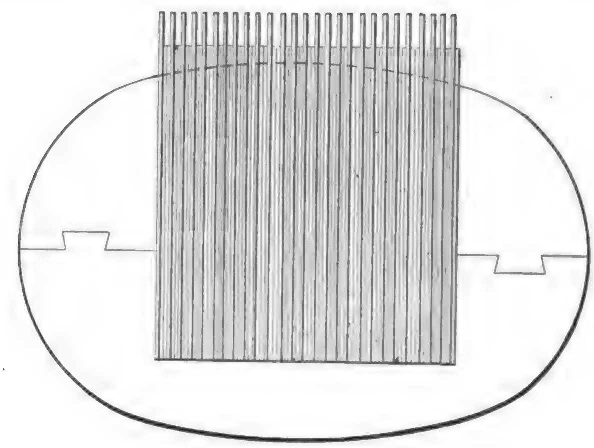


FIG. 5.—BOTTOM VIEW OF FIELD MAGNETS.

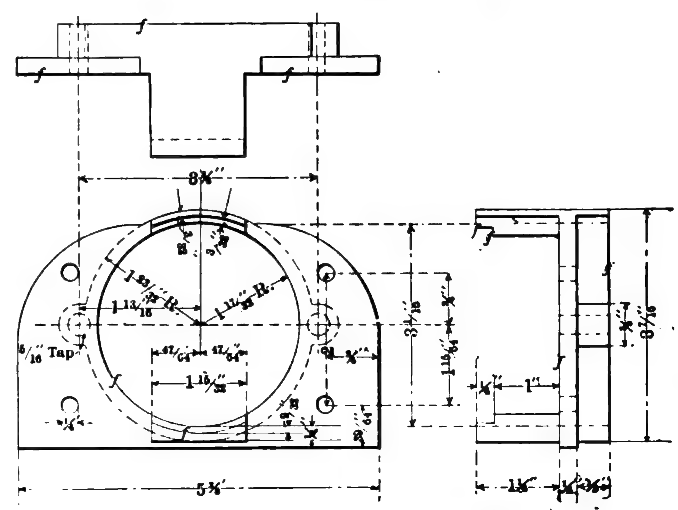


FIG. 7.—FIELD CLAMP, PINION END.

ture slots, extending to a little beyond the ends of the armature, and a plug is put in each slot to hold the fibre in place. The

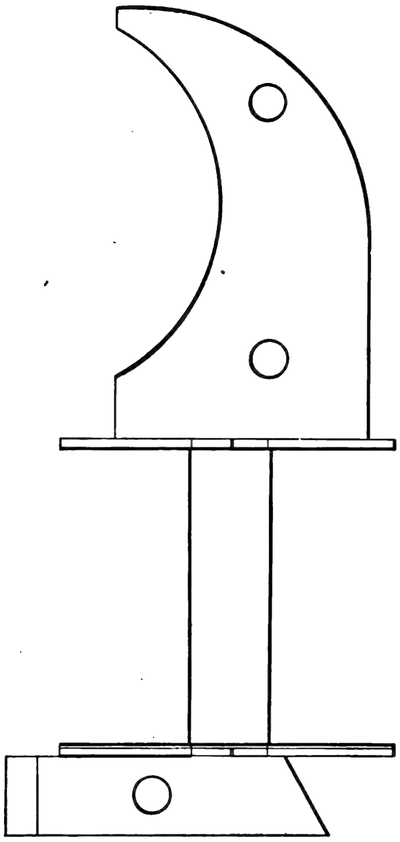


FIG. 6.—FIELD MAGNET PUNCHING.

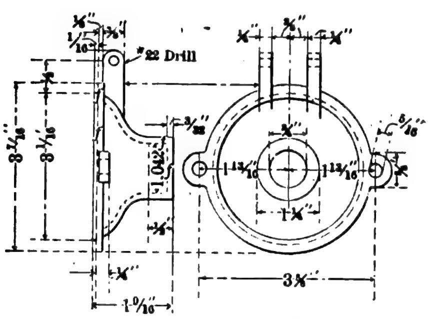


FIG. 10.—BEARING SUPPORT.

and a ⅛-in. hole drilled in each end, deep enough to cut through the tube on each side, and into the discs and shaft, thus forming a keyway. A pin is driven in each hole, which should be drilled ¼ or ⅜ ins. deep.

The shaft on each side of the armature should be covered with some insulator to prevent the wires from grounding on it; this insulation should extend a little beyond where the wires will come. A thin fibre tube or a thin fibre sheet wrapped around the shaft and held in place will suffice. The armature is now ready for the armature

wind slots 10 and 18; then choose a pair of slots as far removed as possible, say 4 and 14 and 5 and 13; after winding each coil

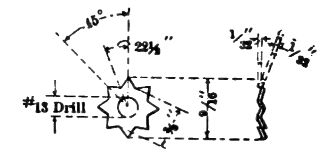
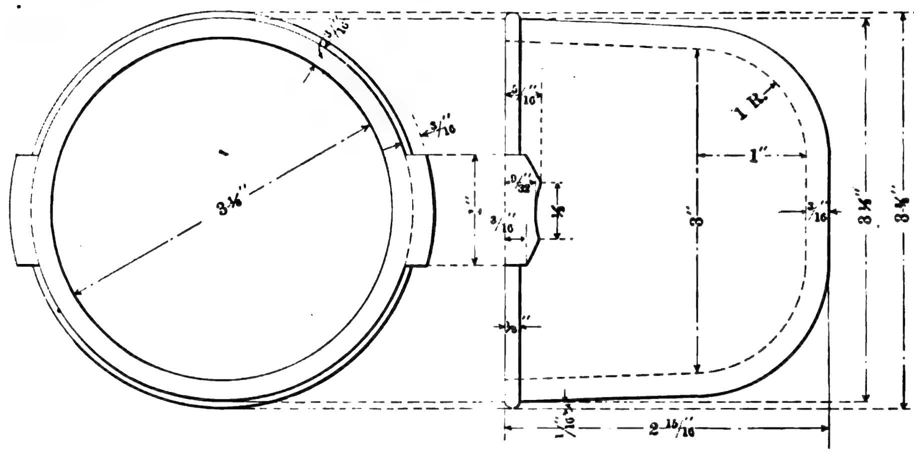
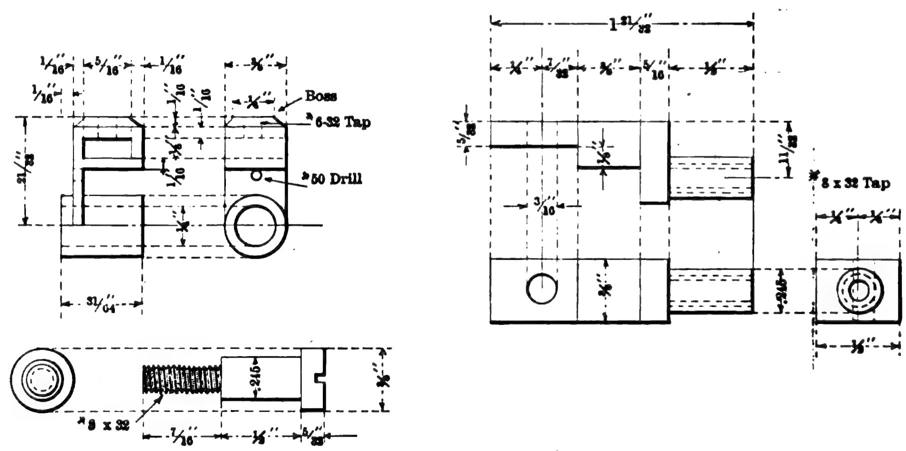


FIG. 15.—SPRING ADJUSTER.

give the armature one-half turn. This will leave two slots directly opposite each other to be wound. The outside coils are wound



GLASS COMMUTATOR COVER.



FIGS. 12, 13 AND 14.—BRUSH-HOLDER, SUPPORT AND SUPPORT SCREW.

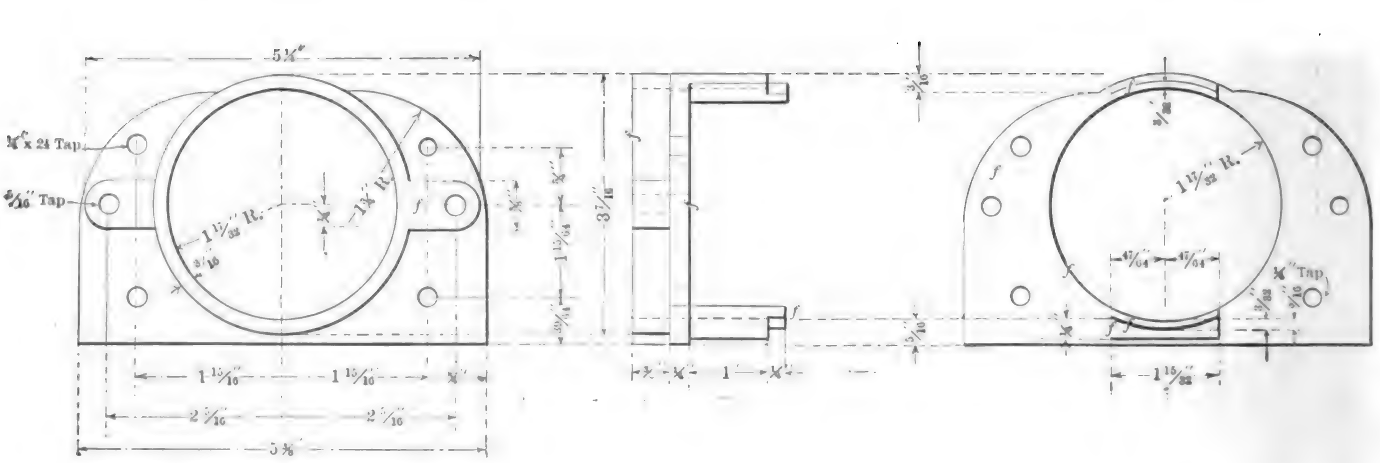


FIG. 11.—FIELD CLAMP, COMMUTATOR END.

armature is then baked and allowed to cool. When cold, the plugs are pulled out of the slots, the bolt removed, and the heavy metal discs taken off. The armature core will then appear as one solid piece of metal.

The armature is now forced on the shaft

wires. The writer prefers the spiral winding, but for one not having much experience the skip winding is simpler. Commencing with the wire toward the commutator, wind slots 1 and 9 (see Fig. 8); then give the armature one-half a turn and

the same as the first, starting the wire in the slot diametrically opposite the one in which the coil already in these slots was started. The starting wire of each coil should have a knot or other means of identification in it to identify it when connect-

ing it to the commutator. It is necessary to use care in winding the armature to protect the insulation on the wire from injury, so that a coil may not be short-circuited on itself or grounded on any part of the armature or shaft. This motor was designed for thirteen turns of No. 18 double cotton-covered magnet wire in each coil, or twenty-six wires in each slot. It is advisable to put a piece of linen over each pair of coils on the end of the armature so when the next pair is wound across them there will be no danger of the wires cutting through the insulation, and each coil should be shellaced and the armature baked after the winding is finished. The commutator is next put on the shaft and secured with a set screw or pin, care being exercised to put the screw or pin as near the end as possible, so that there will be no danger of grounding the bars.

The terminals of the armature windings can now be soldered to the commutator, a flux being used that will not corrode the wire; rosin is safest. The inside or starting end of one coil should be soldered to one bar with the outside end of the coil next to it, all the coils being connected in this way. This operation completes the armature.

The commutator is a difficult part to make unless one has special machinery; but a suitable one can be made from either a

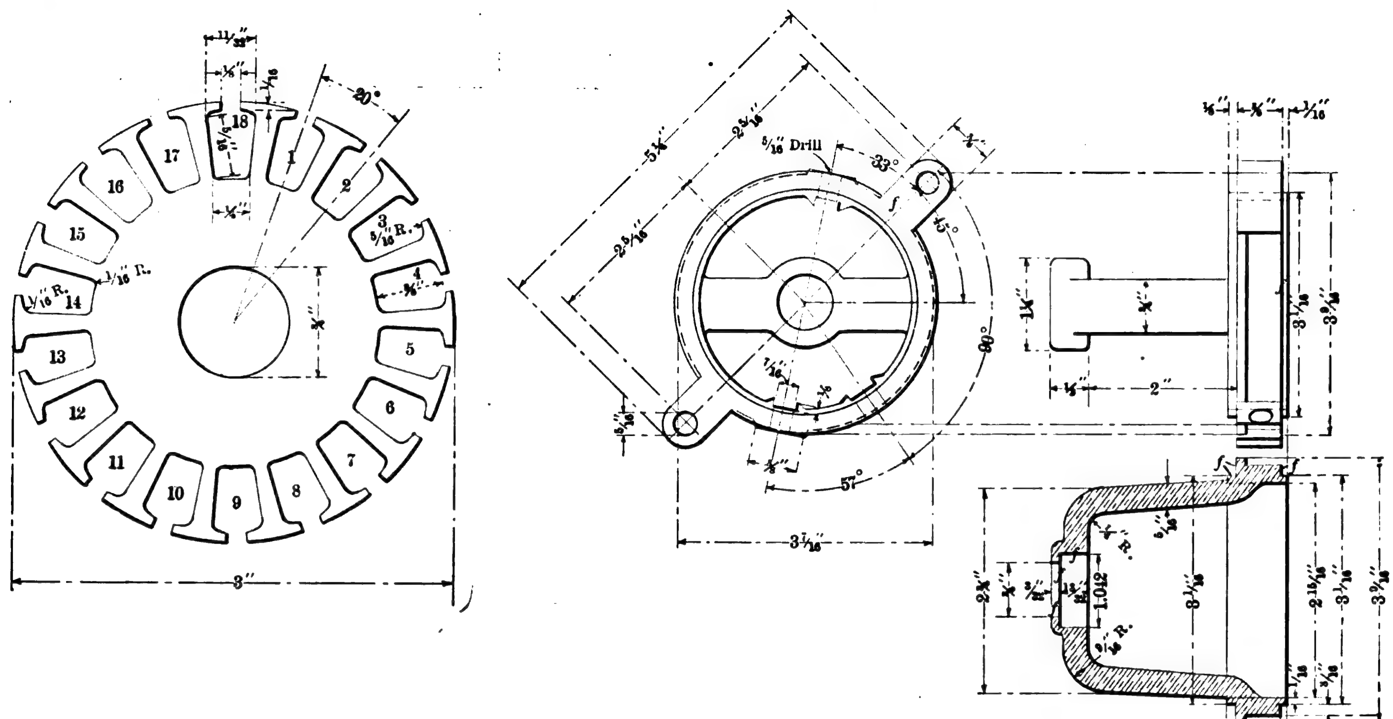


FIG. 8.—ARMATURE PUNCHING AND BRASS YOKE.—FIG. 9.

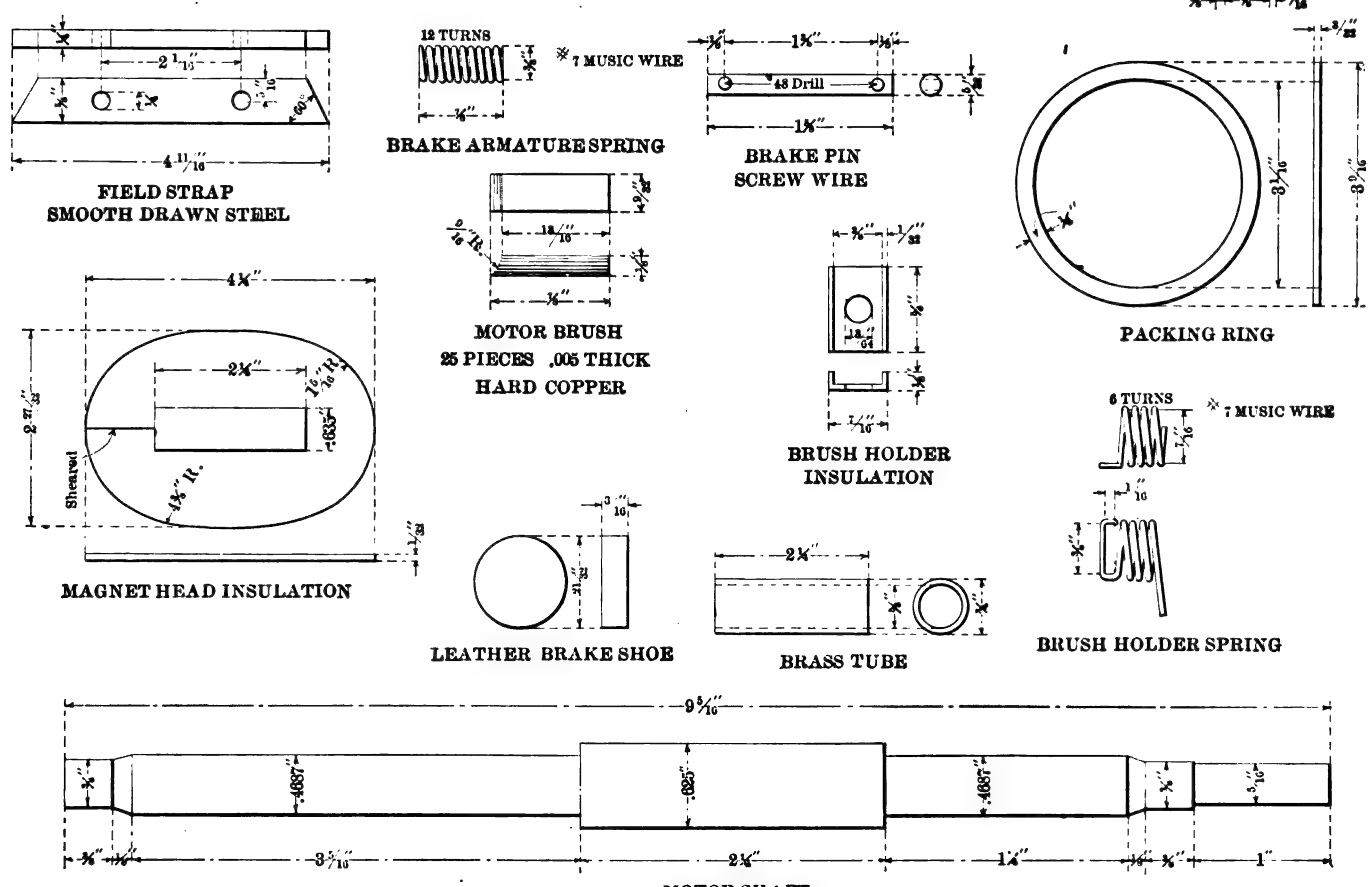


FIG. 16.—DETAILS OF MOTOR.

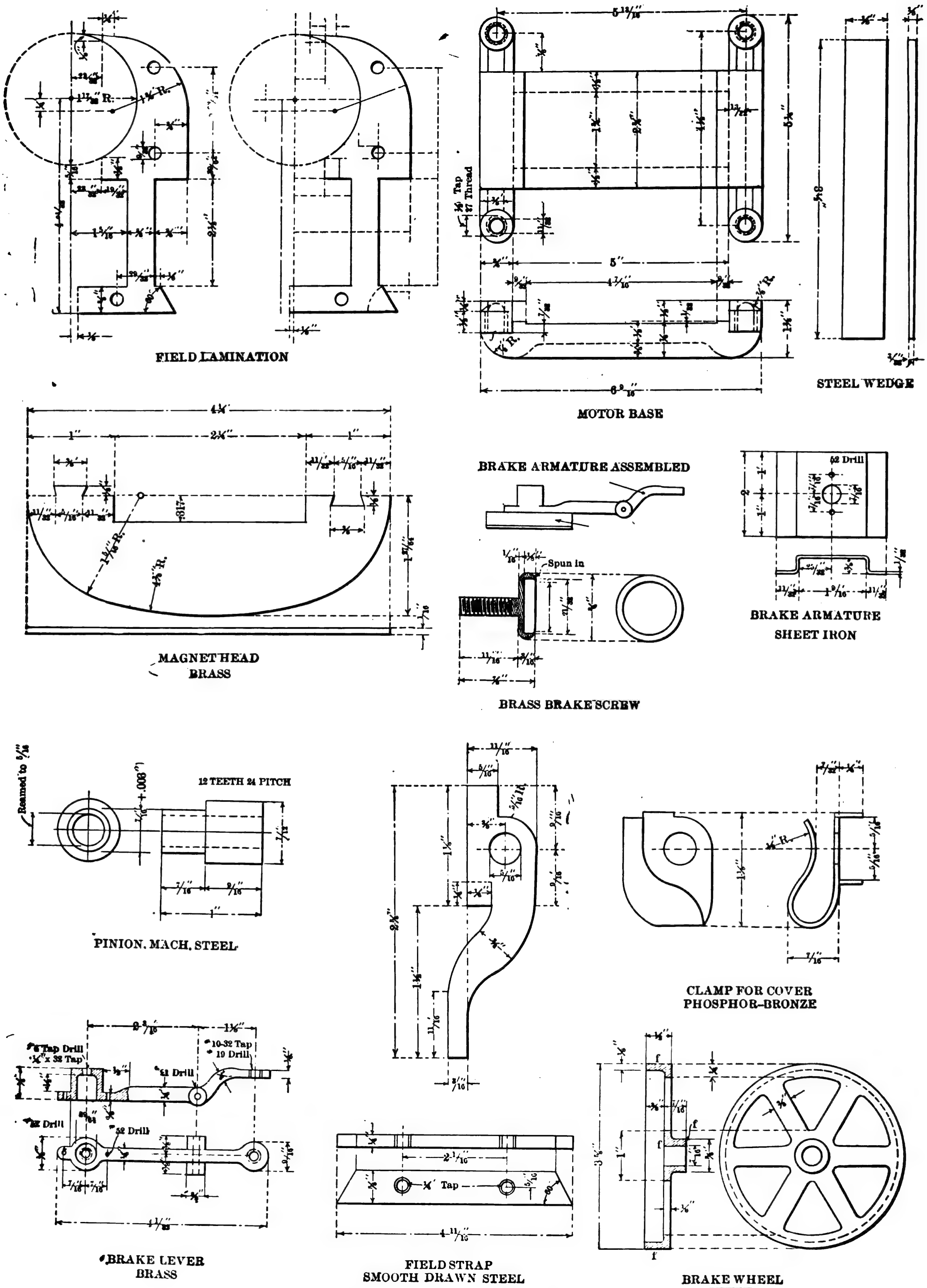


FIG. 17.—DETAILS OF MOTOR PARTS.

piece of copper as large in diameter as the commutator is to be, a piece of rod or very heavy tube, and boring the inside to the right size to fit the sleeve with the insulation on. This should be soldered on an arbor which has been turned on centers to fit it. The arbor is placed on centers, the ends of the copper turned to the proper taper, and the outside nearly to size; it can then be put in a milling machine and the tube cut in the proper number of sections, using a thin cutter. After this, enough heat to melt the solder is applied, and the segments will drop off the arbor. The commutator segments can now be assembled on the sleeve with mica and shellac, the nut screwed up tightly, and the whole baked. After it has baked a couple of hours the nut should be tightened up as much as possible while the complete commutator is hot. When the commutator is cold, it should be mounted on the armature shaft and a finishing cut taken over the face; this will insure the commutator running true on the shaft.

The armature is designed to run on ball bearings, one of which is shown in section on the end of the shaft. Bearings of this type can be bought already made. The bearing support for the pinion end, Fig. 10, encloses the armature on the end; it is finished with a shoulder which fits inside the field clamp, Fig. 7, so that it will always take its proper place when put on. The yoke, Fig. 9, is finished so that the shoulder fits in the field clamp, Fig. 11. Channels are cut in the inner surface of the ring for holding the brush-holder supports in their proper positions. The outer edge of the ring of the yoke is made a finished fit for the glass bell and a soft leather washer is put between the glass and the metal to make a tight joint. The glass bell is held against the leather by two springs bearing against lugs on the glass; this completely encloses the armature and commutator, and enables the attendant to see the condition of the commutator and brushes. The glass cover may be removed by turning it partly around; this moves the lugs from under the springs. To replace it, the cover is held against the leather and turned slightly to bring the lugs under the springs.

The brush-holder supports, Fig. 13, are secured in two channels cut in the ring of the yoke, by a square head screw passing through the support and the ring, with nuts on the outside, which serve as binding posts.

This being a series motor, one end of the field winding is connected to one of these posts, and the other is connected to the battery wire. The third channel in the ring serves to hold a square head screw to be used as a binding post to connect the other end of the field and the other battery wire. The brush-holder supports and the screws are insulated from the ring by a flat piece of insulation bent around the support and bushings through the ring.

One brush-holder, Fig. 12, is placed on the support, and another on the screw fastened in the end of the support. Each brush-holder has a separate spring. Two washers, Fig. 15, are placed on the screw, Fig. 14, which jams them against the end of the support, Fig. 13. The end of each brush-holder spring is fastened to its respective washer.

To adjust the tension on the brushes the screw, Fig. 14, is loosened and the washers, Fig. 15, turned until the proper tension on each brush is obtained; the screw is then tightened and holds the washers in the proper positions.

The motor runs at a speed of 2,256 r.p.m. when supplied with current at a potential of 11 volts, using ½ ampere. On a brake test the motor made 1,240 r.p.m., exerting a pull of 10 ounces at a 2-in. radius, consuming 2.2 amperes at 11.5 volts. For ordinary use many changes might be made in the design. The glass covering for the commutator with its parts might be omitted, as well as the entire braking mechanism for stopping the motor when the power is off. Other minor modifications might possibly present themselves.

TABLE I.—MOTOR DETAILS.

Part No.	No. Req.	Name of Part.
14.151	1	Bearing support, with 2 5/16x¾-in. steel cap screws.
14.152	1	Yoke, with 2 5/16x1⅛-in. steel cap screws.
14.153	1	Glass commutator cover.
14.154	1	Packing ring.
14.155	6	Field screw.
14.156	1	Field strap commutator end.
14.157	4	Brush holder, with 4 ¼-in. No. 6-32 screws.
14.158	2	Brush holder support.
14.159	1	Field strap pinion end.
14.160	2	Clamp for cover.
14.161	1	Brake pin.
14.162	4	Motor brush.
14.163		Field lamination.
14.167	2	Ball bearing.
14.168		Field lamination.
14.169	1	Field clamp, commutator end.
14.170	1	Field clamp, pinion end.
14.171	1	Motor base.
14.172	4	Magnet head.
14.173	4	Spring adjuster.
14.174	4	Brush-holder spring.
14.175	2	Brush-holder support screw.
14.176	3	Brush-holder insulation.
14.177	2	Wedge.
14.179	1	Brake, armature and lever.
14.181	1	Brake, armature spring.
14.184	1	Brake, armature screw with 10x32 hex. nut.
14.193	1	Pinion.
14.186	1	Pinion screw, with No. 10.32 hex. nut.
14.187	1	Pinion shoe.
14.188	1	Pinion cover, with 2 No. 8-32x¼-in. screws.
14.183	1	Brake pin, with 2 ½-in. cotters.
14.190	1	Armature complete.
20.93	6	Knurled nut, with 9 brass washers, No. 10, and 3 fibre washers, No. 10.
	2	1 ⅜-in. No. 10-32 sq. hd. brass screws, with hex. nuts.
	1	1 ¼-in. No. 10-32 sq. hd. brass screws, with hex. nuts.

BOILER POWER FOR LIGHTING AND POWER PLANTS.

BY CHAS. L. HUBBARD.

It is often necessary to estimate quickly the boiler power required for heating, lighting or power purposes, and at such times a simple method giving results of sufficient accuracy for all practical purposes may be of considerable value. The following data have been used by the writer with satisfactory results and may be easily condensed and placed in a note book for easy reference. Computations for power boilers are based on the steam consumption of the type of engine used, and vary even with the same type of engine, depending upon the size, speed, pressure carried, and point of cut-off. The accompanying table (1) gives about the average steam consumption per indicated horse-power per hour for first-class engines of medium size.

TABLE I.

Type of engine.	Pounds of steam indicated horse-power per hour. Non-conds'g.	Conds'g.
Simple high speed	30—34	22—26
Simple Corliss	26—30	20—24
Compound high speed.....	24—28	18—22
Compound Corliss	22—26	16—20
Triple exp. high speed....	22—26	16—20
Triple exp. Corliss........	20—24	14—18

The higher figures may be used for engines of 75 to 200 horse-power and the lower figures for engines of 200 to 500 horse-power. For engines smaller than 75 horse-power, the figures should be slightly increased.

Having determined the probable weight of steam required per hour, and knowing the temperature of the feed-water and the boiler steam pressure to be carried, the weight of steam required can be reduced to an equivalent evaporation from and at 212 degrees, and this result divided by 34.5 will give the boiler horse-power required.

Before taking up a practical example, it may be well to state briefly just what is meant by "equivalent evaporation." It is known that the latent heat of evaporation varies with the pressure, and that the "heat in the liquid" varies both with the pressure and with the temperature of the feed-water. These facts show that in making comparisons of the efficiency of boilers working under different conditions, the working conditions of each must first be reduced to a common standard. This standard is called the "equivalent evaporation from and at 212 degrees," and is best explained by the following example:

A boiler carrying a pressure of 90 pounds gauge, and supplied with feed-water at a temperature of 60 degrees, evaporates 3,000 pounds of water per hour. What is its equivalent evaporation from and at 212 degrees? Reference to steam tables will show the temperature of steam at 90 pounds pressure to be 331 degrees, and the "latent heat of exaporation" 881 heat units; then for one pound of steam the "heat in the liquid" above the temperature of the feed-water is $331 - 60 = 271$ heat units, and the "total heat" is $271 + 881 = 1152$ heat units. Therefore, the heat required to raise the temperature of 3000 pounds of water from 60 degrees and evaporate it into steam at 90 pounds pressure is $115 \times 3000 = 3{,}456{,}000$ heat units.

Referring again to a steam table, one finds the "latent heat of evaporation" for steam at 0 or atmospheric pressure to be 966 heat units; therefore, $3{,}456{,}000 \div 966 = 3577$ pounds, which is the weight of water that would be evaporated from a temperature of 212 degrees into steam at atmospheric pressure by the same amount of heat. The ratio,

$3577 \div 3000 = 1.19$, is called the "factor of evaporation."

Tables giving the factors of evaporation for all conditions of feed-water temperature and steam pressure can be found in any engineers' handbook. To use such a table, look in the first column for the temperature of the feed-water supplied; then follow to the right until the column corresponding most nearly to the given boiler pressure is reached. The number here found will be the factor of evaporation for the case in hand, and the actual quantity of water evaporated multiplied by the factor thus found will give the equivalent evaporation from and at 212 degrees.

For example: What is the horse-power of boiler required to supply steam at 100 pounds gauge pressure from feed-water at 60 degrees temperature for a compound condensing Corliss engine of 200 indicated horse-power? Taking the higher water rate from Table I for this type of engine, we have $200 \times 20 = 4000$ pounds of steam required per hour. Reference to a table of the factors of evaporation shows the factor for the condition given to be 1.19. Therefore, $4000 \times 1.19 = 4760$, which is the equivalent evaporation from and at 212 degrees, and $4760 \div 34.5 = 138$, the boiler horse-power required.

If steam is to be used for other purposes, such as the running of feed pumps, etc., the power must be increased accordingly. It is also well to allow a margin for a future increase in the power of the engine, should occasion require it. In computing the power of a boiler in this manner, it is wise to increase the result obtained from 10 to 20 per cent for the reasons given above.

The boiler power required for running a pump is computed in a similar manner to that already described for an engine. The rating or capacity of a pump, however, is usually expressed in gallons of water per minute raised to a given height, instead of in horse-power as in the case of an engine. The weight of water in pounds per minute, multiplied by the height in feet to which it is raised and divided by 33,000 will give the useful or delivered work of the pump in horse-power. The friction of the moving parts of a pump and of the water through the passages and valves is so great that under ordinary working conditions not much more than 50 per cent of the indicated horse-power of the steam cylinder is utilized in doing useful work. This calls for a large consumption of steam in proportion to the work done, and from 80 to 120 pounds of steam per delivered horse-power is common in this class of pumps. The higher figure should be used for small boiler feed-pumps, while 100 pounds may be taken as a fair average for pumps of moderate size. In measuring the head against which a pump is working, the vertical distance between the surface of the water in the suction reservoir and that in the discharge reservoir is taken. If the pump is delivering against a pressure, as in feeding a boiler, the pressure should be reduced to "feed head" by dividing the pressure in pounds per square inch by .4.

For instance, if a pump is discharging 4000 pounds of water per minute into a tank 50 feet above it, and the surface of the water in the reservoir from which it is taken is 10 feet below the pump, $50 + 10 = 60$ feet, the total head against which the pump is working, and $4000 \times 60 \div 33{,}000 = 7.2$ horse-power.

Again, if a boiler feed-pump is delivering 200 pounds of water per minute against a pressure of 150 pounds per square inch, the water being taken from a reservoir 5 feet below the pump, the boiler horse-power may be ascertained as follows, assuming the pump to use 120 pounds of steam per delivered horse-power-hour, $150 \div .4 = 375$ feet head, $375 + 5 = 380$ feet total head, and $200 \times 380 \div 33{,}000 = 2.3$ delivered horse-power, from which the steam required will be $2.3 \times 120 = 276$ pounds per hour. If the temperature of the feed-water is 60 degrees and the boiler pressure 150 pounds, the factor of evaporation will be 1.2, and $276 \times 1.2 = 331$ pounds, the equivalent evaporation from and at 212 degrees. Therefore, $331 \div 34.5 = 9.6$, the boiler horse-power required.

In the above example it has been assumed that the horizontal runs in the suction and discharge pipes are short, and no account has been taken of friction.

The power required for electric lighting can be determined very nearly by assuming that one horse-power of electrical energy will supply a given number of lamps of different types, as indicated in the following table:

TABLE II.

No of lamps supplied by 1 h.p.	Type and power of lamp.
12	16-c.p. incandescent lamps..
6	32-c.p. incandescent lamps.
2.5	1200-c.p. arc lamps.
1.7	2000-c.p. arc lamps.

The efficiency of a first-class generating set (engine and dynamo) including the losses in transmission may be estimated at about 75 per cent, so that the electric horse-power necessary to supply the lamps divided by .75 will give the indicated horse-power of the engine required. From this the boiler horse-power can be determined as already described.

For example, it is desired to find what boiler horse-power will be required to furnish steam for a lighting plant carrying 2400 16-c.p. and 600 32-c.p. incandescent lamps and 100 1200-c.p. arc lamps; the boiler pressure to be 100 pounds and the feed-water delivered at an average temperature of 70 degrees. The engines are to be high-speed compound non-condensing, using 28 pounds of steam per indicated horse-power. Dividing 2400 by 12, the number of 16-c.p. lamps supplied by one horse-power according to the table, equals 200; $600 \div 6 = 100$, and $100 \div 2.5 = 40$, making a total of 340 horse-power of electrical energy required of the dynamos; $340 \div .75 = 453$ indicated horse-power of the engines; $453 \times 28 = 12{,}684$ pounds of steam required per hour. Since the factor of evaporation for 100 pounds steam pressure and 70 degrees temperature of feed-water is 1.15, $12{,}684 \times 1.15 = 14{,}586$ pounds, the equivalent evaporation from and at 212 degrees, and $14{,}586 \div 34.5. = 422$, which is the boiler horse-power required.

When a building contains a power plant the exhaust steam is usually turned into the heating system. In this case, the boiler power for supplying the engines and pumps is first computed, and about 80 per cent of the steam furnished for this purpose may be considered available in the exhaust for heating purposes. If this is less than is required for heating in the coldest weather, additional boiler power must be provided to make up the deficiency.

In designing a plant of any considerable size, it is better to use two or three smaller boilers rather than a single large one, and it is also well to provide for a certain amount of reserve power for use in case of break-down, or when it is desired to shut down a boiler for cleaning or inspection. In a heating plant, if sufficient power is provided for the coldest weather, there will be much of the time when only part of the boilers will be in use; but in the case of a power plant where the demand for steam is practically constant one or more extra boilers, depending upon the size of the plant, should be kept in reserve.

GROUND DETECTORS AND THEIR CONNECTIONS.

BY JAMES T. COE.

When the current in a wire escapes by any means to the ground, the wire is said to be grounded. This grounding may or may not entail serious trouble, depending on whether the circuit is purposely grounded or not. In electric railway systems, for instance, where the track circuit is grounded, no damage results unless a second ground of low resistance occurs between the trolley circuit and the earth. This would be the same as a direct short-circuit, and were it not for the fact that the generators and instruments are protected by fuses and circuit-breakers which instantly interrupt the circuit under such conditions, much damage would result. In the Edison three-wire system in which the neutral wire is grounded, an accidental connection between either of the outer wires and a gas or water pipe would cause current to flow which may be serious in its effects. In a circuit otherwise free from grounds, as for example a two-wire circuit, an accidental ground between one wire and the earth would not be fraught with serious consequences; but should a second ground occur between the other wire and the earth, current will flow through the connection thus established, the extent of the resulting damage, if any, depending on the e.m.f. of the circuit and the resistance of the grounded connections. The secondaries of transformers and many arc light systems are grounded, the better to protect the lives of people in case of mishap. Transformer cases are also grounded so as to protect users from shock due to primary leakage and accidental contact with the transformer case.

The causes of grounds are many and varied. It must be borne in mind that current always has a tendency to escape and

hence the need of insulation to prevent it. Where this is broken trouble may be looked for. In long transmission lines a broken insulator would allow the bare wire to touch the pole and thus establish a connection through the pole to ground. Trees falling across wires, branches swayed by the wind striking them, or grounded wires such as telegraph or telephone wires coming in

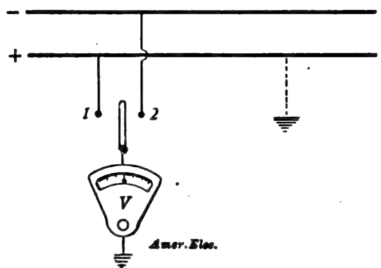


FIG. 1.

contact with electric light wires, cause grounding. In interior work a wire may come in contact with gas, steam or water pipes, or with iron girders, etc.; but the widespread use of conduit precludes such possibilities. When the contact is not good, or where the resistance of the conducting material is high, only a very small current will pass; on the other hand, if such is not the case and the resistance of the grounded connection is low, enough current will flow to temporarily, at least, disable the system.

The purpose of a ground detector is to indicate the presence of such grounds which are not readily discernible, and which if permitted to exist might cause serious trouble. A heavy ground needs no detector since it does not stand on ceremony in announcing its presence, and usually makes itself known by the blowing of fuses and the opening of circuit-breakers. Where these protective devices are not installed the apparatus usually receives its quietus, accompanied by weird noises and fireworks. Ground detectors may be connected directly to the circuit so as to indicate grounds just as soon as they occur, or they may be normally disconnected from the lines and thrown into circuit when it is desired to

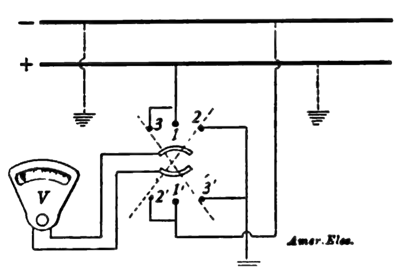


FIG. 2.

test the lines for grounds. It is the purpose of the writer to describe the various types of ground detectors in use and to show how these are connected to the circuits.

A voltmeter makes a very convenient ground detector since it indicates the presence of a ground as well as its comparative resistance. This instrument may be connected to direct-current mains as indicated in Fig. 1. The positive and negative mains are connected to contacts 1 and 2, respectively, of the switch *S*, which is connected to ground through the voltmeter. The voltmeter is double deflecting so that the needle swings in either direction, depending on the direction of the current. If the positive line should become grounded as indicated, and the switch placed on contact 1, no deflection will take place, since both the ground and the instrument are on the same side of the circuit. If the switch is thrown on contact 2 current will pass from the positive main to the ground and back through the voltmeter to the negative main, thus completing the circuit. When a deflection is obtained on the voltmeter with the switch on contact 1 it indicates that the negative lead is grounded, and conversely if a deflection is obtained with the switch on contact 2 it indicates that the positive main is grounded. Should the resistance of the ground be great the voltmeter deflection will be small, and if the resistance be small the voltmeter deflection will be large.

Many direct-current voltmeters require that the current shall always pass through them in one direction and unless this obtains no deflection will take place. This condition is illustrated in Fig. 1, from which it will be evident that the current

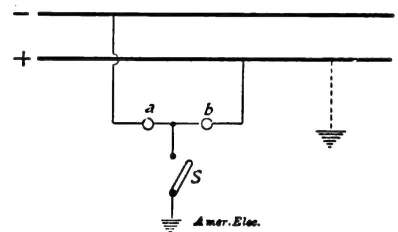


FIG. 3.

flows in opposite directions with the switch on contact 1 and on contact 2, and unless a double deflecting voltmeter is used a ground can only be detected on one main. To make such a voltmeter indicate grounds on both mains a special switch must be provided. The voltmeter can then serve the double purpose of a voltmeter and a ground detector. Fig. 2 shows such a switch. With the switch on contacts 1-1′ the voltmeter, which is a single-scale instrument, is connected across the line and indicates the voltage on the system. With the switch on contacts 3-3′ any ground on the negative wire will be detected, and with the switch on contacts 2-2′ grounds on the positive lead are indicated, the current always passing through the voltmeter in the same direction.

A very common arrangement for detecting grounds on a circuit in which incandescent electric lamps are used is shown diagrammatically in Fig. 3. The lamps are connected in series across the line, and the voltage of each lamp is the same as that of the generator, so that when placed in series the lamps merely burn with a dull red color. The ground connection is made through a switch, one end of which is connected to the wire between the lamps as indicated. When the circuit is closed at *S*, if no ground exists on either line, both lamps will still burn with a dull red glow. If the positive main is grounded, however, very little current will flow through the lamp *b*, since an easier path is provided through the lamp *a*, switch *S*, ground and thence to the negative main. In consequence the lamp *b*, which is thus shunted by the ground connection will be extinguished, and lamp *a* will receive the full potential of the circuit and burn at its rated candle-power. The lamp which becomes dim or entirely extinguished indicates that

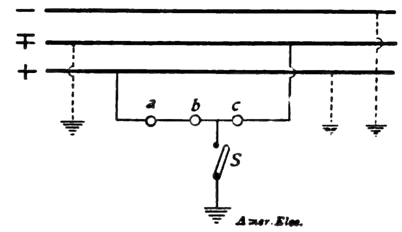


FIG. 4.

the ground is on the lead to which it is connected, while the brightly burning lamp indicates that the lead to which it is connected is clear.

For a three-wire system a modification shown in Fig. 4 is used. Here three lamps are connected across one side of the system. Connection is made with the ground through the switch, *S*. The lamps all burn with the same degree of brilliancy, a dull red, and if the switch is closed and the lines are free from grounds no change is noticeable. If, now, the positive main becomes grounded and the switch is closed, lamp *c* will be connected across the neutral and negative mains, and lamps *a* and *b* will be extinguished. Lamp *c* will consequently burn at full candle-power. Should the neutral become grounded, lamp *c* will be extinguished; but since lamps *a* and *b* are connected in series they will increase appreciably in brightness, but not burn at their rated candle-power. If a ground occurs on the negative main, all the lamps will burn at full candle-power, since lamp *c* is connected across the negative and neutral leads and lamps *a* and *b* are connected in series across the positive and

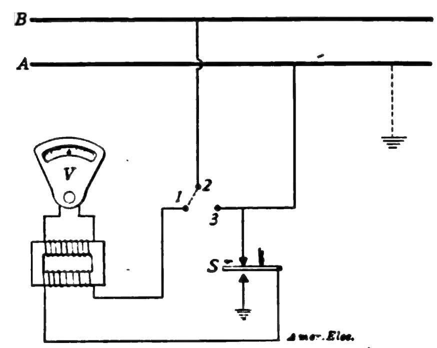


FIG. 5.

negative leads. By this means a ground on any of the three wires is positively indicated.

On alternating-current systems the same general scheme can also be employed to detect grounds, except that potential transformers are employed to step down the voltage so as to be suitable for the voltmeter or lamps, whichever may happen to be used. A diagram of connections for a system of this kind employing a double deflecting voltmeter is shown by Fig. 5. A plug switch is used to connect points

1 and 2 or 1 and 3 together. Ordinarily the primary of the potential transformer is connected across the line through points 1 and 2, so that the station voltmeter becomes available as a ground detector also.

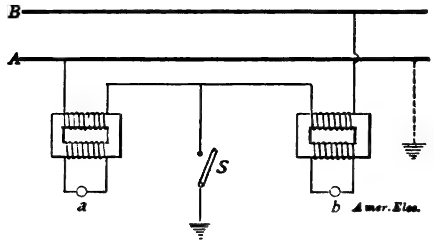


FIG. 6.

A switch, *S*, is used to connect one side of the line to the ground through the primary winding of the transformer. If now a ground occurs on the side of the line marked *A*, the voltmeter will so indicate, and the extent of the voltmeter deflection is a measure of the seriousness of the ground. By placing the plug so as to connect 1 and 3 the other side of the line may be tested. When the switch *S* is in its normal position, the voltmeter performs its normal function as a potential indicator.

For high-tension, alternating-current lines the type of detector shown in Fig. 6 is suitable. Incandescent electric lamps are used and the scheme operates like that shown in Fig. 3; the only difference being that the lamps are fed through transform-

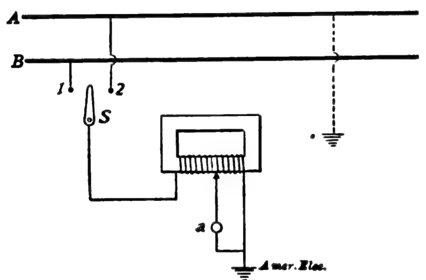


FIG. 7.

ers, the primary coils of which are connected in series across the high-tension mains. Another form of ground detector for high-tension, alternating-current lines, which operates like the detector shown in Fig. 1, is shown in Fig. 7. A coil of wire is wound on the laminated core of a transformer, and the lamp is connected to the grounded end of the coil and to an intermediate point of the coil as indicated. In case either side of the line is grounded current flows through the coil and an e.m.f. is set up between the points where the lamp is connected and the lamp is lighted.

In modern installations all of the alternating-current types of ground detectors already explained are giving place to ground detectors operating on the electrostatic principle. There are two types in general use, each of which will be described. The ground detector shown in Fig. 8 has four fixed vanes arranged around a movable vane of aluminum attached to a pointer. The fixed vanes are connected diagonally in pairs, and each pair is charged statically by one of the line wires through the medium of a condenser. The movable vane is connected to earth. The fixed vanes act inductively on the movable vane so that the stress produced by each pair is equal, but opposite. The movable vane consequently takes a position midway between the fixed vanes which position obtains whether the condensers are charged

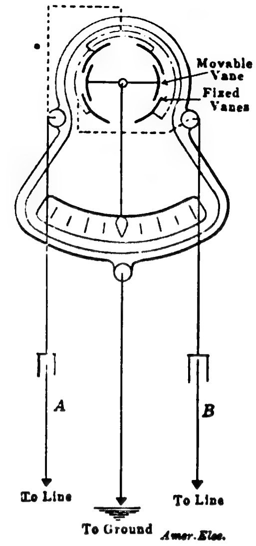


FIG. 8.

or not, so that the pointer rests at zero indicating no ground. Should a ground occur the primary plate of one of the condensers and the movable vane become connected electrically, and the pair of fixed vanes leading to that condenser assumes the polarity of the movable vane, repelling

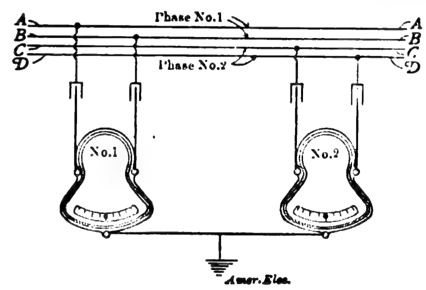


FIG. 9.

the latter. At the same time the other fixed vanes which are of opposite polarity attract. Since the two forces act in the same direction, the movable vane occupies a position within the vanes oppositely charged to it, and the pointer indicates a ground on the side of its deflection. The primary plates of the condensers are connected to the line, and the secondary plates to the fixed vanes of the instrument. The use of separate condensers for charging

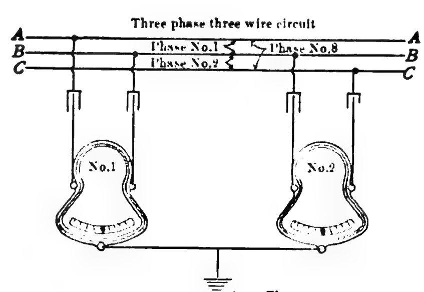


FIG. 10.

the fixed vanes keeps all high-potential currents away from the instruments and also has an advantage in that the instrument may be mounted wherever convenient without regard to the position of the line wires. The condensers may be located at or near the line wires and insulated from each other by as great a distance as may be deemed necessary.

Fig. 8 shows the detector connected to a

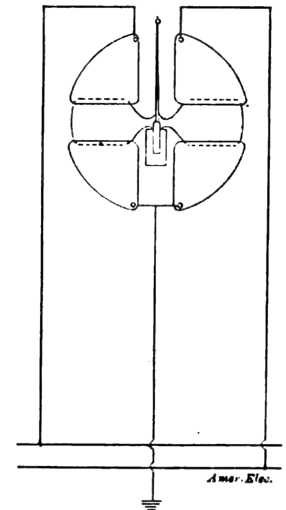


FIG. 11.

single-phase circuit. If a ground occurs in line *A* the pointer deflects to the left, and if the ground is on line *B* the pointer deflects to the right. Fig. 9 shows the connections for a two-phase, four-wire circuit. In this case two instruments are required. Should a ground occur on line *A* the pointer on instrument No. 1 would deflect to the left, and to the right if the ground were on line *B*. If a ground occurs on line *C* the pointer of instrument No. 2 would deflect to the left, and to the right if the ground were on line *D*. The connections for a three-wire, three-phase circuit are given in Fig. 10. With a ground on line *A* the pointer of instrument No. 1 would deflect to the left; with a ground on line *B* instrument No. 1 would deflect to the right, and instrument No. 2 would deflect to the left. Instrument No. 2 deflects to the right if a ground occurs on line *C*.

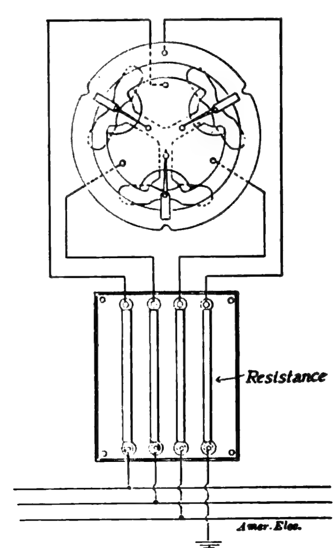


FIG. 12.

The electrostatic ground detector shown in Fig. 11 is similar in construction to the electrostatic voltmeter for laboratory use. The two lower quadrants are connected to ground and the two upper quadrants to the

lines. The vane with its pointer is pivoted at the center of the circle formed by the quadrants and rests normally at zero, lying across the shortest path between the positive and negative quadrants, the upper right and left. When either side of the line is grounded, the lower quadrants cease to be neutral, disturbing the balance of the system and the needle deflects to the right or left, depending on which side the ground occurs. The moving mechanism has no electrical connection with either side of the line or with the ground, and resistances are sometimes placed in series with the instrument. A three-phase ground detector is shown in Fig. 12. This is practically a combination of three single-phase instruments symmetrically arranged and enclosed in a case. When no ground exists the three needles point to zero, and when a ground occurs on one of the lines the two adjacent needles are deflected toward the segments to which the grounded line is connected. If a ground occurs on two lines the needle between the segments connected to the grounded lines will be deflected toward the one having the lower resistance ground and the two remaining ones will be deflected toward the grounded segments.

THE MISUSE OF SWITCHBOARD INSTRUMENTS.

BY K. S. HOWARD.

One of the most practical questions in connection with the operation of electric power plants is the use of the switchboard instruments. Unless such apparatus is properly treated the conclusions of the owners in the matter of operating expenses and economy are likely to go far astray from the truth. A poor instrument is worse than no instrument at all, when it comes to estimates of the cost of generating each unit of power output, and a good instrument mistreated is perhaps worse than either.

To secure the best results from one's instruments it is well to begin with their shipment from the factory. In most cases both time and money will be saved by shipping instruments by express instead of by freight, on account of the greater care which the express companies take in transporting such products. Instruments should never be shipped attached to the switchboard on which they are to be used. The reason for this is not far to seek, and as one manufacturer has well expressed it, "anyone who has ever spent a night on a marble slab in a freight car will understand why a small amount of paper and excelsior with a berth in an express car saves most of the tiring effects of travel." In foreign shipments the cases ought not to be opened until they reach the point of destination. Some makers ship instruments by water, enclosed in hermetically-sealed metal cases surrounded on the outside by wooden packing cases. It is almost impossible to reseal this kind of metal case after it has once been opened, and its use is necessary for the proper protection of the instrument from water.

When a consignment of instruments arrives at the plant it is poor practice to break the seals for the purpose of getting acquainted with the interior construction of the different types. The idea prevails in some quarters that seals are provided simply to protect the instrument maker, but as a matter of fact they also protect the user, and in cases where the latter is not at fault the unbroken seal places the responsibility for repairs or replacement upon the manufacturer. No sensible engineer can reasonably expect an instrument maker to assume responsibility for performance when the seal is broken and the apparatus injured by unskilled tinkering. An examination of any instrument by its maker almost always enables him to tell at once why the apparatus did not operate and whether the trouble is due to defective material, poor workmanship or misuse on the part of a customer.

The proper location of switchboards is a question of much importance, for it is highly desirable to avoid the influence of external magnetic fields and to mount the panels on solid foundations entirely separate from the foundations of the machinery. If any perceptible vibration is transmitted to a switchboard the instruments may easily receive more wear in a single day than in many months of service on a steady set of panels.

In mounting series ammeters care should be taken to see that the leads do not form a loop within which the voltmeter or any other instrument will be located. Cases have occurred where the ammeters were located at the top of the switchboard, with leads from the circuit-breaker and main switch running up on each side, forming a loop or solenoid within which the voltmeter was mounted. With a flow of current varying from 0 to 1200 amperes this construction means that the voltmeter is subject to a varying field which may act with or against its own field with an intensity of 1200 ampere-turns. Such a field is probably much more intense than the field within the instrument itself; hence it cannot be expected that the instrument will indicate correctly, for no magnetic shield can be provided which will protect it from such a powerful external field.

There is little sense in mounting instruments 8 or 9 feet above the floor line and expecting attendants of normal height to be able to read them. As one instrument maker has cogently remarked, "Eight-foot attendants are scarce and expensive." Nor is it a good plan to mount instruments upside down, or to place them on top of excited dynamos or motors. The practice of chiseling out holes in a switchboard and riveting up the frame after the instruments are attached is almost certain to result in broken jewels. Rough usage of any kind, even if an instrument is securely held in its box, is inexcusable. If through accident or carelessness an instrument is dropped, it should be calibrated before being used in any service where accurate indications are of consequence. A gentle tapping of the case with the finger should be the extreme method of adjusting an instrument by force, and it is always well to make sure that the leads are connected to the proper terminals and that the pointer stop is released before attempting to place an instrument in service. Contacts ought to be cleaned thoroughly at the start, set up tight and kept free from looseness, dirt and grease if good results are desired. There is little to be gained from polishing a plated instrument daily with sand soap or emery. In using either a switchboard or a portable instrument it is well not to rub the glass which covers the scale before taking a reading, on account of the static charges which such a rubbing induces in the moving parts. These charges interfere with the accuracy of the reading, but can easily be dissipated by lightly touching the glass above the needle with the finger, when the pointer will return to the zero position. Overloading an instrument beyond its maximum scale reading opens the way toward poor satisfaction with its behavior, as does leaving in circuit instruments designed for intermittent use. When properly treated, electrical instruments require little attention beyond occasional calibration, and their maintenance expense should be nominal. High precision is attained, even in many switchboard instruments now on the market, but unless reasonable care is taken to avoid abusing such apparatus the money expended to secure accuracy is largely wasted.

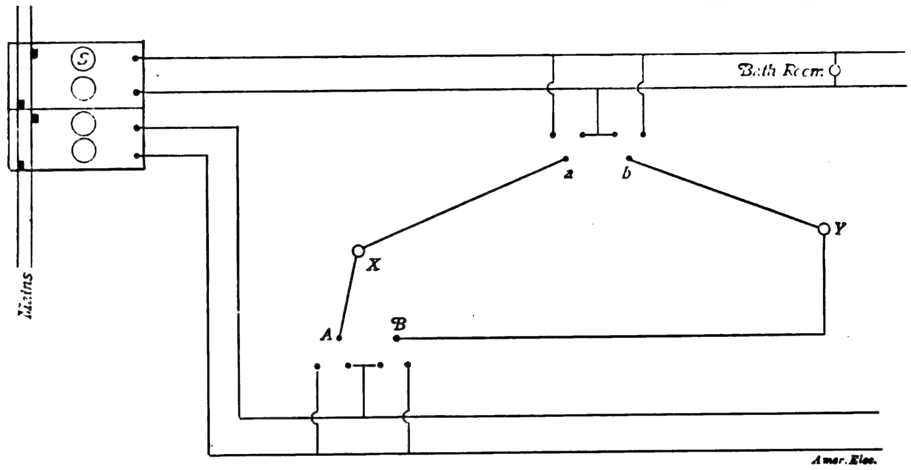
Letters on Practical Subjects

Communications intended for publication in this department must be received at this office not later than the 15th of the month prior to the date of publication.

Reversing the Polarity of Generators.

I find the many practical letters and other articles published in your paper a very great help to me, and just what an engineer needs to steer him through the many and trying problems that come up. I believe every man who has charge of engine and boiler rooms should have near him a reference of some kind so that when trouble occurs he may refer to it for a remedy, and for that reason a single number of the AMERICAN ELECTRICIAN should not be missing from his desk. Having had considerable trouble at one time with generators which reversed their polarity, I feel that perhaps the remedies I dug out may be interesting to my fellow readers. There are three methods which might be followed in exciting the fields when generators have become reversed in polarity. Method 1 is used when a machine fails to build up or has become reversed, and both bus-bars are alive through connection with some other station. Method 2 is used when, through the grounding of an armature of one machine, a blow-out occurs with the other machines on the line, so that all be-

come reversed; a tie connection with another station keeping the bus-bars alive, Method 3 is followed when all the available generators have become reversed and the bus-bars are not alive. When using the first method, before separately exciting the machine, the shunt field coil should be tested in order to ascertain whether there is an open circuit in it or not. To sepa-



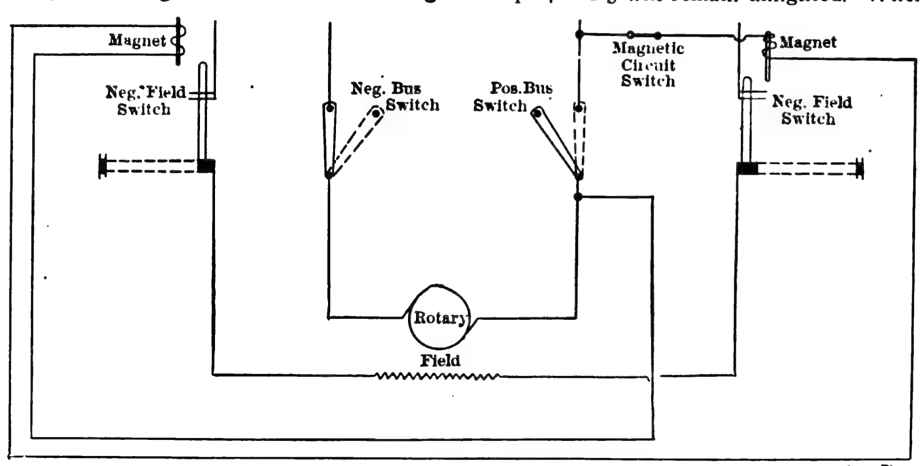
SOLUTION TO MR. HARTMAN'S PROBLEM IN HOUSE WIRING.

rately excite the machine the procedure is as follows: (1) Put one or more machines which are not reversed on the line in regular service. (2) Close the equalizer circuit of the machines and also the equalizer switch of the defective machine. (3) Close the positive switch of the defective machine and after these switches have remained closed for a few seconds open the positive and equalizer switch of the machine which was separately excited and this machine may then be started and built up in the regular manner. If a defective machine is running during the time that it is desired to reverse its polarity, the shunt field switch should be opened before closing the above-mentioned switches. Then a few seconds after these switches are closed, the field switch may be closed, and the machine should then build up as usual. When using Method 2, the engineer should proceed as follows: (1) Open the field switch of the machine it is intended to separately excite. (2) Pull out one of the wires from the binding post as a precaution. (3) Cut out about one-half of the field resistance. (4) Close the positive switch of the generator. (5) By means of a wire connect the pivot of the field switch back of the board with the ground. It is preferable to have a fuse in circuit with this wire. (6) After this connection has been made for a few seconds, remove it, slowing drawing out an arc while so doing. (7) Reinsert the wire in the binding post and build up the machine in the usual manner. If one or more machines still remain reversed change them back to normal by Method 1, putting the machine just given its right polarity back in service on the line. In using Method 3, in order to obtain a source from which to excite the fields of the other machines, build up one of the reversed machines and proceed as follows: (1) Open the field switch of the machine to be separately excited. (2) Remove the wire from the binding post of this machine. (3) Make a connection back of the board by means of a wire between the lower stud of the normal negative switch of the machine which has been built up in the reversed direction and the lower stud of the normal positive switch of the machine which it is desired to separately excite. (4) As a precautionary measure connect a fuse between the lower stud of the normal positive switch of the machine which is reversed and the pivot of the field switch of the machine it is desired to separately excite. (5) After the connection has been made for a few seconds remove the connecting wire slowly drawing out an arc during the removal. (6) Insert the wire in the binding post again and build up the machine in the usual manner.

Cambridge, Mass. W. A. Dow.

Field Circuit Control.

In enclose herewith a diagram by means of which the opening of the field circuit of a machine is prevented while the machine is in operation. Referring to Fig. 1, in which the rotary converter is represented as stopped, it is evident that when the rotary is running the armatures of the mag-



FIELD CIRCUIT CONTROL.

nets drop by gravity and prevent the field switches from being opened. When the positive bus switch is opened the rotary will gradually come to a standstill, and after it has stopped the magnets will be energized and will lift their armatures, thereby permitting the field switches to be opened.

New York City, N. Y. A. J. DUNLOP.

Mr. Hartman's Problem in House Wiring.

No solutions were received for Mr. Hartman's problem in house wiring as published in the November number, and since his trouble was due to a trifling defect in the fuse plug, and not to any error in the wiring connections, the problem might be deemed unfair. We have received many diagrams of connections, which with perfect fuse plugs would overcome the defective lighting; but the problem did not call for the connections. Fig. 1 shows the correct diagram of connections as given by the author of the problem, and also shows where the trouble was found. A piece of solder in the fuse plug *S* would not allow the plug to make contact.

Mr. Simon's Problem in Arc Lamp Wiring.

Enclosed is a solution of Mr. Simon's arc lamp problem published in the November

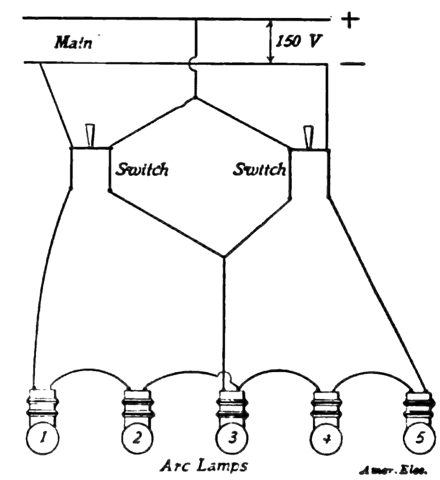


FIG. 2.—MR. MAURY'S SOLUTION.

number. 1, 2, 3, 4 and 5 are 35-volt series arc lamps, and *E* is a two-way switch. With the switch in the position shown, lamps 1, 2 and 3 will be lighted while lamps 4 and 5 will remain unlighted. When the switch is in the position indicated by the dotted lines, lamps 3, 4 and 5 will light and lamps 1 and 2 will be extinguished.

Greensburg, Pa. J. HARVEY BUTLER.

As a solution to Mr. Simon's problem in arc lamp connections, I submit the accompanying diagram (Fig. 2). If desired three single-pole switches or three plug

switches may be used in place of the two two-pole switches shown.

Rossville, Ill. JACK MAURY.

[Similar solutions were also received from F. A. Cocker, Salem, Mass.; E. C.

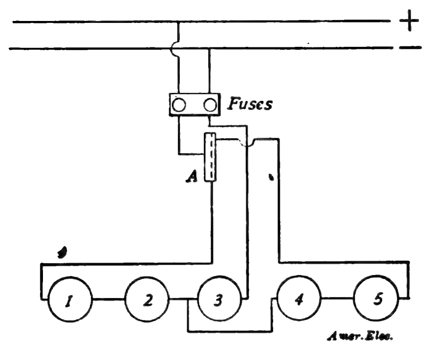


FIG. 3.—MR. ROWLEY'S SOLUTION.

Daggett, London, Tenn.; J. K. Kates, H. F. McCullough, Wilkinsburg, Pa.; and N. C. Pervier, Cedar Rapids, Ia.—EDITOR.]

I enclose herewith a solution to Mr. Simon's problem published in the November number. Switch *A* may be either a single-pole, double-throw knife switch or a two-way snap switch.

Syracuse, N. Y. C. A. ROWLEY.

[Similar solutions were also received from C. F. Abele, New York City; R. F. Becker, Marquette, Mich.; C. D. Bowman. Chicago, Ill.; F. B. Bremer, Toledo, Ohio; L. W. Duncan, Chicago, Ill.; F. J. Cummings,, Devils Lake, N. D.; W. H. Hufft, Excelsior Springs, Mo.; D. C. McMeehan, Victor, Colo.; J. L. Remaley, Schickshinny, Pa.; J. C. Runyon, Rahway, N. J.; E. J. Schuetzler, San Francisco, Cal., and J. F. Smith, Anderson, Ind.—EDITOR.]

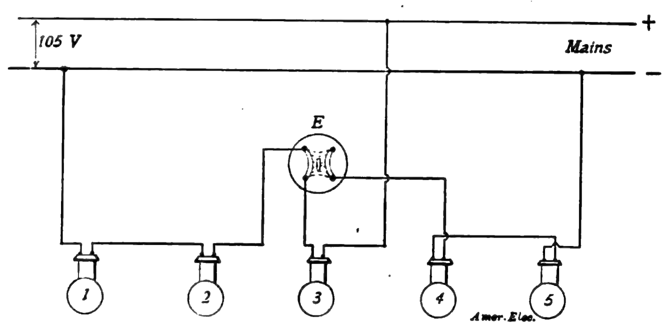


FIG. 1.—MR. BUTLER'S SOLUTION.

The lamp problem offered by Mr. Simon in the November issue may be readily solved as indicated in Fig. 4, which shows how five series arc lamps might be connected so that lamp No. 3 will operate with lamps No. 1 and No. 2 or with lamps No. 4 and No. 5; each lamp requiring 35 volts and the combination of three lamps in series being thrown across the 105-volt mains.

West Lynn, Mass. DUNKLE A. PURCELL.

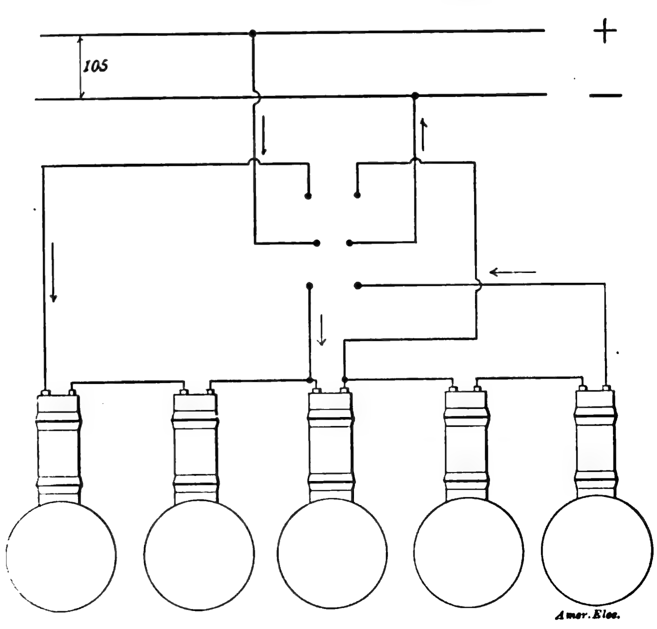


FIG. 4.—MR. PURCELL'S SOLUTION.

[Mr. Purcell's solution is similar to Mr. Simon's. Similar solutions were received from F. A. Bunks, St. Joseph, Mich.; S. J. Chapman, Wabash, Ind.; C. J. Corse, State College, Pa.; W. L. Diffendorf, Akron, Ohio; J. B. Dillon, Louisville, Ky.; W. K. Dimock, Brooklyn, N. Y.; S. Eisner, New York City; J. D. Elder, Detroit, Mich.; O. B. Eve, Augusta, Ga.; H. A. Fiske, Kingston, R. I.; L. J. Gorilla, Ironwood, Mich.; C. M. Hamilton, Charlotte, N. C.; O. Hood, Martinsville, Ind.; C. H. Jarvis, Charlotte, Mich.; E. S. Lincoln, Brookline, Mass.; A. F. Lippincott, Spokane, Wash.; H. E. Maxson, Scranton, Pa.; S. G. FacFadden, Monterey, Mex.; R. McDaniel, Port Arthur, Tex.; C. H. Morrison, San Matio, Cal.; C. W. Petry, Washington, D. C.; J. F. Post, New Haven, Conn.; W. H. Spahn, Brooklyn, N. Y.; R. Q. Swaffield, Elkhart, Ind.; A. H. Sweetnam, Chicago, Ill.; A. Weinberg, Zanesville, Ohio; and J. R. Wilson, Pottsville, Pa.—EDITOR.]

Fighting a Gas Franchise.

Your readers will doubtless be interested in the manner in which the local lighting company here succeeded in keeping gas out of Maryville, despite the fact that the whole political organization and the press were in favor of such a plant. The lighting company was charging $8 a month each for arc lamps and $2 a month each for 32-c.p. incandescent lamps, lighting the city hall free of charge. When the contract expired the company was notified that if it continued its lighting it would receive only $7 for each arc light. Meanwhile the city council were becoming interested in gas, and the *Daily Tribune* was boiling with enthusiasm over gas. Not being able to supply the lights at the price offered, the company shut off the street lighting service at the expiration of its contract, and the city was left in darkness for about ten days, when an agreement was reached whereby the old price would be paid until some other arrangement could be effected. Shortly afterwards, a request was made by a Chicago capitalist for a franchise to build a $70,000 coal gas plant. This request was evidently to the liking of the council, for they immediately went into executive session, passing an ordinance and also signing a secret agreement whereby they pledged the city to enter into a ten-year contract with the gas company ten days after the ratification of the ordinance, to light the city with gas mantle lamps at the rate of $3,500 a year. A special election was called to vote on this ordinance, the context of which, by the way, was never communicated to the public. The election notice concluded with the statement: "If you vote YES it will be taken by the board that you have assented to the granting of the franchise in the manner and form and according to all the provisions provided by said ordinance." The press being hostile to the interests of the electric light company, the only way in which the latter concern could obtain the ear of the public was through the publication of a separate paper.

The company accordingly published a four-page paper, which they called the *Daily Gas News,* in which it was clearly pointed out that the company was not in any fear of competition, and was not fighting a reasonable franchise, but merely the plan of the politicians to wrest from the city an outrageous contract in an illegal manner. Only four issues of the *Daily Gas News* were required to thwart the scheme of the politicians, for matters became so hot that the Chicago capitalist withdrew his proposition. The result is there is no gas in Maryville.

Maryville, Mo. RICHARD PECK.

Questions and Answers

Inquiries not accompanied by the name and address of the inquirer, will not receive attention.

Can a three-phase induction motor be run as a generator? G. A. P.

Yes, if it is driven above synchronous speed and has its field excited from an alternating-current source.

In connecting an indicating instrument to a switchboard carrying a low potential alternating current, should series transformers be used? R. S.

The use of series transformers even on circuits of comparatively low potential seems to be increasing. The added convenience in removing or cutting out instruments for recalibration and the added security for the switchboard operator, more than compensate for the slight error introduced by their use.

Which would give better service, two engines of 8 and 9 horse-power respectively coupled to one shaft, or one engine of 17 horse-power? M. D.

A 17-h.p. engine would be the more economical. The mechanical efficiency or ratio of the delivered horse-power to the indicated horse-power decreases very rapidly as the size of the engine decreases. The friction loss and loss by condensation in an 8-h.p. engine and a 9-h.p. engine would exceed considerably the corresponding loss in a 17-h.p. engine.

I am using woven-wire brushes on a shunt-wound bipolar dynamo generating 350 amperes at 110 volts. I have always had considerable trouble with sparking and desire to change the brushes for something better. Would carbon brushes answer? H. R. L.

Carbon brushes would undoubtedly give better service as regards sparking, but it is hardly practicable to use them in this case because they would run too hot, the collecting surface of the commutator being designed for copper brushes. You might try a set of high-resistance brushes.

What is the difference between a starting rheostat and a rheostat for controlling the speed of a motor? N. Y. C.

A rheostat for controlling the speed of a motor does not differ in general construction from a starting rheostat. The main difference is that the regulating rheostat must be capable of carrying current continuously without overheating, whereas a starting rheostat is designed to carry current for a short time only. A regulating rheostat has, therefore, to be much larger than a starting rheostat.

How may I make a horseshoe magnet? K. S. L.

Horseshoe magnets are made of steel similar to that used for making edged tools. Tungsten steel is the best for the purpose. The bar of steel is first bent to shape and then hardened. The steel should be so hard that a file will make little impression on it. After the steel is hardened, it may be magnetized either by bringing it in contact with a powerful magnet, such as the pole-pieces of a dynamo, or by winding a coil of wire around each leg of the horseshoe and sending a strong current through the coil.

What causes a 20-kw. 220-volt direct-current dynamo to at times send out a small ring of sparks which completely encircle the commutator. This occurs usually on the commutator face about one inch from the outside end, but sometimes shows the same distance from the other end. Commutator compound usually starts this stream of sparks. The commutator is in fine condition and the machine does not give trouble otherwise. N. M.

The sparking is probably due to particles of dirt that bridge over between the commutator bars. Commutator compound usually contains graphite and particles of this will cause these fine sparks by connecting adjacent bars and by drawing out small arcs from the brushes. These fine sparks are not harmful nor do they indicate any defect in the machine. They are common where carbon brushes are used, and if the commutator is occasionally wiped off will be greatly reduced.

A 250-light generator operating at 125 volts has been used three years. The commutator is in good condition and the machine is not overloaded. Carbon brushes are used and one of them gives a great deal of trouble; it gets very hot and burns away after a few days' use. How may I remedy this trouble? A. S. M.

Since the machine is not overloaded the excessive heating of the brush is probably due to improper commutation. The brushes may be located so that there is an excessive current in the coil under commutation at the moment it is short-circuited by the brush. Try rocking the brushes back a little, if this can be done without sparking. If the brush has too low a resistance, excessive current may flow through it during commutation and this may account for your trouble.

How can I change the direction of rotation of a shunt-wound motor, of a series-wound motor and of a compound-wound motor? What is the effect of weakening the field of a shunt-wound motor, and also of a series-wound motor? Why? E. M.

The direction of rotation of a motor may be changed by reversing the current either through the armature or through the field coils; but not through both. If both are changed the motor will run in the same direction as it did before the change was made. Weakening the field of a shunt-wound or of a series-wound motor would result in an increase in speed in both cases. Since the counter e.m.f. of a motor is directly proportional to the number of lines of force cut, the armature must revolve more rapidly with a weakened field in order to generate the necessary counter e.m.f.

Is it possible to obtain a two-phase current from a three-phase current by using three-transformers? I have a three-phase generator and testing board and would like to have this equipped for two-phase work if possible. C. P.

You can obtain two-phase current from a three-phase line by the use of three transformers; but two transformers would answer, and would be preferable. These may be connected according to the Scott method. The primary of the first transformer is connected to the center of the primary of the second transformer, and the number of turns on the secondary of the first transformer should be $2 \div \sqrt{3}$ times the number of turns on the secondary of the second transformer, the primary turns of both transformers being equal in number.

When installing transformers in districts how much greater capacity than needed should be provided for probable increase in load? S. E.

This is rather difficult to answer. There are two ways in which unnecessarily large transformers cause a loss to central stations: 1. Interest and depreciation on the extra investment involved. 2. Increased core loss. The total yearly loss per kilowatt of surplus transformer capacity varies with average size transformers from \$3 to \$4. The only way to gauge the maximum load on a line to which a transformer is connected is to place a demand indicator in series with the transformer, connecting it to the secondary of the transformer, unless this is large, in which case it should be connected to the primary. The maximum load being thus made known it is then a question depending on the conditions whether or not to install a larger transformer. The transformer will stand a continuous overload and probably this overload capacity will be sufficient to take care of the increased demand for some time; or the demand indicator may be left in circuit permanently and no increase in transformer capacity provided until the demand indicator would so indicate.

Will a current-transformer of a certain capacity and a known ratio of transformation used with an indicating wattmeter give a true reading using the formula, ratio of current transformer times wattmeter reading equals true watts? W. W.

No. Instrument transformers do not correctly perform their function of delivering to the meter those fractions of line pressure and of line current called for by their ratios. The pressure delivered from the secondary coils of a pressure transformer will vary with the amount of load that is put upon the transformer by reason of the impedance drop in its coils. Where wattmeters are supplied through a transformer phase displacement between the primary and secondary electromotive forces takes place. The error in the case of a current transformer arises not directly on account of the impedance of the coils, but because not all of the primary current is transformed, part being used to magnetize the core. When this component is subtracted vectorially, the remainder is transformed at the true ratio. Consequently two errors are introduced: the quantity of secondary current is too small, unless the ratio of the transformer is changed by removing the proper number of turns from the secondary coil; and the phase of the secondary current is different from the phase of its primary. You will find this matter fully discussed in a paper read before the American Institute of Electrical Engineers by J. D. Nies; the title of the paper being "Some Notes on Polyphase Metering." This paper is printed in the April, 1905, *Proceedings of the American Institute of Electrical Engineers.*

New Apparatus and Appliances

REVERSIBLE SINGLE WIRE CLEAT.

Figs. 1, 2 and 3 show a new form of single wire cleat brought out by H. D. Murdock, of Pittsburg, Pa. A particular

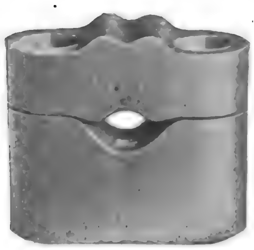


FIG. 1.—REVERSIBLE WIRE CLEAT.

feature of this cleat is the reversible top by means of which two different sizes of cleats in combination with a bottom piece

FIG. 2.—REVERSIBLE WIRE CLEAT.

may be formed. Two bottom pieces can also be combined to form a larger cleat, as indicated in Fig. 3. By knocking out a small rosette in the bottom piece a screw

FIG. 3.—REVERSIBLE WIRE CLEAT.

or tack can be used to hold the bottom independent of the top.

DOUBLE-JOINT DESK FIXTURES.

The accompanying illustrations show a

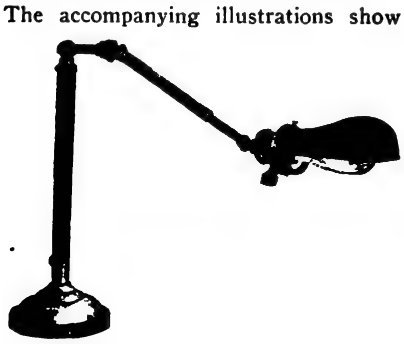


FIG. 4.—DOUBLE-JOINT DESK PORTABLE.

new line of double-joint desk fixtures placed on the market by McLeod, Ward & Co., of New York City. As the name implies, there is a double-joint movement near the base, and a single-joint movement at the socket, enabling a light to be placed at any point desired within the range of the fixture without loosening or tightening screws. The joints are so constructed that they may be moved freely without straining or in any way injuring the flexible plate which is concealed in the tubes. One style of these fixtures is arranged with two brass clamps, which can be fitted over a roll-top desk and then tightened in place, making a perfectly rigid fixture. Another style is arranged with a back clamp similar to that used on the Kinsman desk lamp, which has an adjustable front clamp. The fixtures

FIG. 5.—FIXTURE FOR ROLL-TOP DESK.

are all fitted with telescoping tubes similar to those used in the well known Kinsman desk fixtures. This makes them suitable for small or large desks. The fixtures are well constructed, and with the old line of desk fixtures manufactured by the company cover the lighting field pretty thoroughly.

IMPROVED GATE VALVE.

The Lunkenheimer Company, of Cincinnati, Ohio, has brought out the gate valve shown in section by Fig. 6 herewith, which, it is claimed, embodies many improvements. The valves are made of iron with bronze trimmings, in three different weights for working pressures of 125, 150 and 250 pounds per square inch, and are also made in bronze for 150 and 250 pounds pressure. The valves are made with stationary stem or with outside screw and yoke. The seat rings as well as the wedge

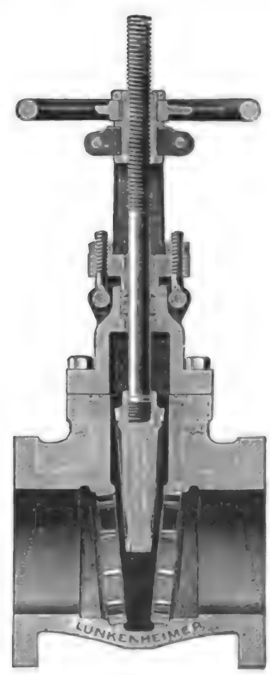


FIG. 6.—GATE VALVE.

disc, may be renewed when worn. That portion of the valve body which receives the seat rings is threaded to the angle of the tapers of the valve disc. The seat rings are also threaded and faced off straight and when screwed in place are said to fit accurately the tapers of the disc. The disc in both forms of valve is made of bronze up to and including the 6-in. size, above which they are made of iron with bronze seat trimmings. These rings are forced on the disc, a flange on the ring being flared out in a groove cut at an angle in the iron disc. There is thus no danger of the rings dropping off. Either pattern of the gate valves can be packed under pressure when wide open. The stuffing box in the valve with the stationary stem, is made of bronze, and is tightly screwed into the hub. In the valves with outside screw and yoke both the gland and stuffing box are lined with bronze bushings. The discs are accurately guided in the bodies, and by means of the guides, the stems are relieved of all side strains, which have a tendency to wear out threads. The stems in both forms of valves are made of rolled tobin bronze. All parts of the valve are heavy and compact, and the valves are not affected to any appreciable extent by expansion or contraction.

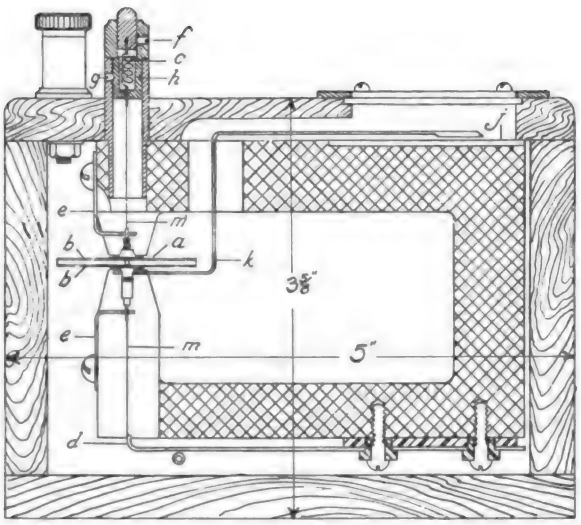
PORTABLE MOVING COIL GALVANOMETER.

The Leeds & Northrup Company, of Philadelphia, has brought out the portable moving coil galvanometer shown herewith, a novel distinguishing feature of which is the method of suspending and winding the moving system. The suspension consists of upper and lower filaments, and in this particular differs from the pivot and jewel ordinarily used in instruments of the portable type. The magnetic field is produced by a U-shaped cast iron permanent magnet having inwardly directed poles at one end so as to have north polarity only on one

FIG. 7.—PORTABLE GALVANOMETER.

side of the air gap separating the poles and south polarity only on the other side of the air gap. The magnet is slotted so as to accommodate the moving system. The air gap between the poles being very short, the

field is uniform and intense. The moving system consists of four flat coils of very fine wire wound alternately in opposite directions, so as to produce alternate north and south poles when viewed from one side.



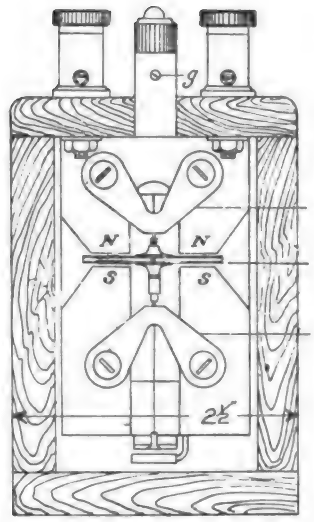


FIG. 8.—PORTABLE GALVANOMETER.—FIG. 9.

These coils are held between two aluminum disks, *b,* and suspended in such a manner that normally only a portion of each coil extends into the air gap between the magnet poles, though at all times only about one-half of the coil surface is between the pole faces. It is evident, therefore, that when current is passed through the coils two of the coils of like polarity will then swing around to inclose the greatest number of lines of force, while the other two coils of like polarity will be repelled. The aluminum discs, *b,* also serve the purpose of damping the system and rendering it dead-beat. The galvanometer can be given a high, medium or low resistance by connecting the coils in series, series-parallel or parallel. The suspensions consist of three wire filaments. To give the entire system resiliency in the event of sudden jars, the upper suspension terminates in a spiral spring, *c,* and the lower suspension is attached to a long flat phosphor bronze spring, *d.* An additional protection against excessive strains on the moving system is provided by means of two guards, *E.* These guards have clearance holes to provide for the rotation of the system, but limit the sidewise movement or play of the system, thereby arresting the movement of the coil due to any sudden shock. The movement of the system vertically is limited by the pole-faces of the magnet. The torsion head, *f,* provides a delicate zero adjustment and by means of the screw, *g,* operating in an annular groove, *h,* engages the end of the groove and thus acts as a stop to limit the extent to which the torsion head may be turned. The magnet with its complete moving system and scale is mounted in a highly polished mahogany case having a circular opening in the top protected by a glass window for the scale. The binding posts are securely mounted as indicated and are arranged to clamp large or small wires. The outside dimensions of the case are 5 ins. by 2½ ins. by 3½ ins. high.

WESTINGHOUSE "TYPE C" TRANSFORMERS.

The Westinghouse Electric & Manufacturing Company has placed upon the market a new line of core type transformers known as Type C. The transformers have operating characteristics closely approximating those of Westinghouse type O. D. transformers, and are intended for general distribution service on 60-cycle circuits operating nominally at 1,050 and 2,100 volts, although they will operate successfully on

FIG. 10.—FRONT VIEW OF TRANSFORMER.

voltages up to 1,200 and 2,400. They are manufactured in sizes from .6 to 50 kilowatts and are divided into classes according to the voltages of the secondary. Class 200 may be connected for either 105 or 210 volts, and class 400 for 210 or 420 volts. The transformer is enclosed in a cast iron case with felt gaskets under the lid, so as to make the transformer absolutely weather-proof. For sizes above 20 kilowatts the case is corrugated to increase the radiating surface. Hanger irons are provided by which any transformer up to and including 30 kilowatts may be mounted on a pole. The core of a type C transformer is built up of carefully annealed steel punchings. The primary and secondary coils are placed on the long sides of the core, the laminations of which are clamped together at top and bottom by suitable end frames. The low-tension winding is composed of one coil per leg, each coil having two sections so connected that the inner section of one leg is in series with the outer section of the other leg. This arrangement results in a

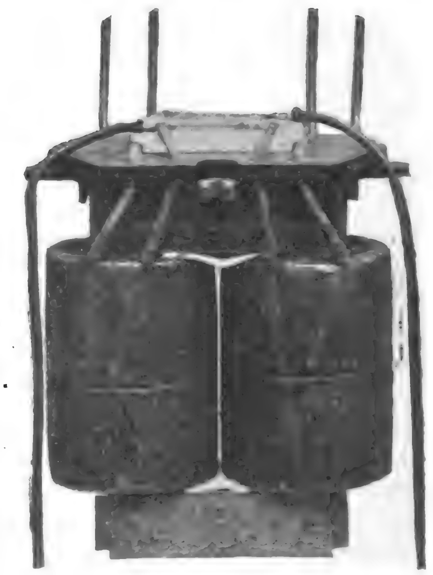


FIG. 11.—INTERIOR VIEW OF TRANSFORMER.

secondary winding of two similar parts both as to resistance and reactance, and insures equal loading of each primary coil irrespective of the method of loading the secondary. A balanced voltage is thus maintained on the two sides of a three-wire distributing system irrespective of the load. The high-tension winding is divided into two coils per leg to reduce the voltage between layers of the winding to a low value. The construction allows the use of a circular coil, which has many advantages. All insulating parts between layers of the winding and between high and low tension coils are cylindrical in form, eliminating sharp corners, which are harmful to insulating material. The windings are so disposed and oil ducts so provided that a free circulation of oil between coils and core is obtained, insuring ready dissipation of the heat and preventing deterioration of the insulation. Very careful attention has been paid to the insulation and liberal allowances made to insure a high factor of safety. All coils are wound to exact di-

FIG. 12.—REAR VIEW OF TRANSFORMER.

mensions and all insulation is cut to gauge, so that corresponding parts of all transformers of the same capacity are interchangeable.

OTIS FEED-WATER HEATER.

Fig. 13 herewith shows a patented feed-water heater recently introduced by the Stewart Heater Company, of Buffalo, N. Y. Fig. 14 is a vertical section of the oil separator and water chamber in line 2-2, Fig. 13, and Fig. 15 is a similar section with the baffle plates omitted. A fragmentary transverse section of one of the baffle plates is shown in Fig. 16. Refer-

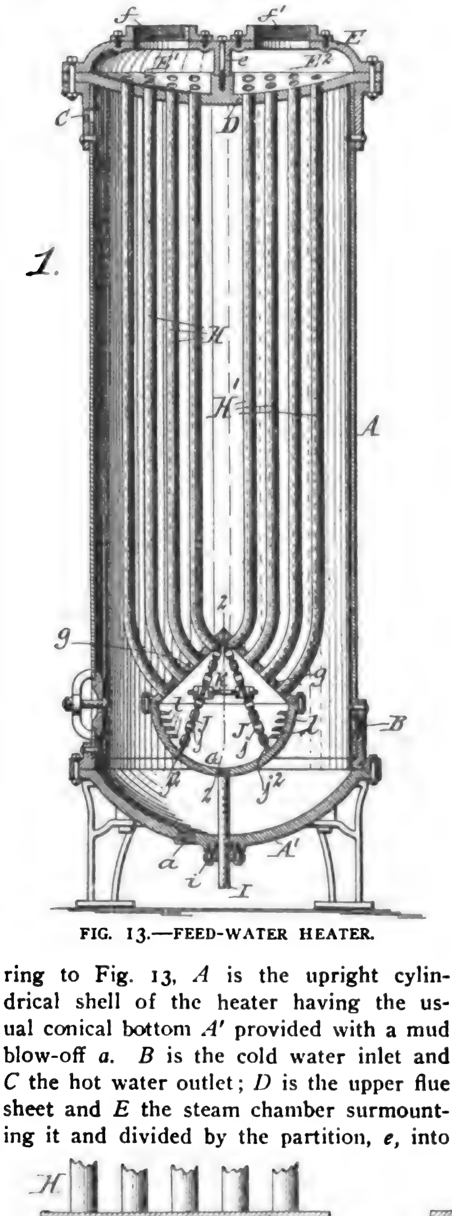


FIG. 13.—FEED-WATER HEATER.

ring to Fig. 13, *A* is the upright cylindrical shell of the heater having the usual conical bottom *A'* provided with a mud blow-off *a*. *B* is the cold water inlet and *C* the hot water outlet; *D* is the upper flue sheet and *E* the steam chamber surmounting it and divided by the partition, *e*, into

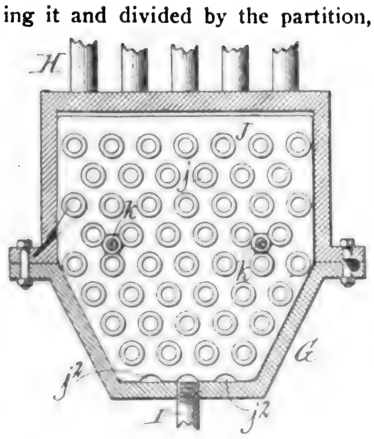


FIG. 14.

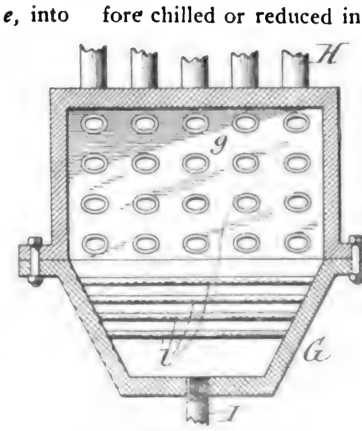


FIG. 15.

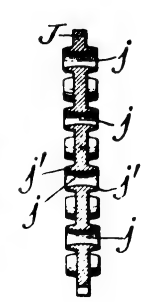


FIG. 16.

the inlet and outlet compartments, *E'* and *E''*, respectively; *G* is the water chamber and *HH'* are the two groups of tubes; *I* is a drain pipe for the oil and condensation. *JJ* indicate a pair of perforated baffle plates arranged in the chamber *G* so that the exhaust steam entering the chamber is compelled to pass through the openings, *j*, before escaping through the other set. The baffle plates are provided with openings over practically their entire surface, and each opening is bounded by a guard rim, flange, or nipple, *j'*, as shown in Fig. 16. In the engraving two baffle plates are shown; these rest upon the bottom of the chamber *G* while their upper ends are arranged in the apex of the angle formed by the inclined flue sheets *g*. The plates are provided with notches, j^2, to permit the passage of oil and water from the portion of the chamber *G* on the outer sides of the plates to the central portion. The plates are held in their proper positions by tie-bolts, *k*. A series of horizontal baffle ribs, *l*, project inwardly from the sides of the chamber. These ribs prevent the steam from carrying the oil and water of condensation through the ascending series of flues *H'*.

In the use of the apparatus the exhaust-steam entering the inlet-compartment *E'* descends through the tubes, *H*, into the oil and water chamber *G*, passes through the openings of the baffle-plates, *J*, and ascends thence through the tubes, *H'*, into the outlet compartment, E^2, from which the uncondensed residue of the exhaust-steam escapes through the outlet *f'*. Any oil carried over from the engine-cylinder with the exhaust-steam flows down the faces of the baffle-plates and collects in the lower portion of the chamber *G*, whence it is discharged through the waste-pipe, *I*, the oil deposited upon the baffle-plates being prevented from running through their openings by the guard-flanges, *j'*. To facilitate the dripping of the oil from these flanges, they are tapered toward their outer ends, as shown in Fig. 16. The chamber, *G*, forms a casing for the oil-separator, as well as a water collecting or condensation chamber. As this chamber is located in the lower portion of the shell or opposite the cold-water inlet, where its contents are coolest, the chamber and the baffle-plates, *J*, remain comparatively cool, and the oil contained in the steam is therefore chilled or reduced in temperature upon entering the chamber, thus greatly promoting its separation from the steam. By thus combining the oil-separator with the cooled condensation-chamber the oil is said to be extracted so thoroughly that the uncondensed residue of the exhaust-steam can be used for other heating purposes. By arranging the guard-flanges, *j'*, of the openings, *j*, on both sides of the baffle-plates the latter will intercept the oil from either side of the chamber, *G*, thus permitting the pipe connections to the steam-inlet, *f*, and outlet, *f'*, to be reversed, if desired, without affecting the oil-separating capacity of the apparatus. To prevent back pressure, the aggregate area of the perforations of each baffle-plate exceeds the area of the steam inlet, *f*.

ELECTRICALLY CONTROLLED OIL SWITCHES.

Figs. 17 and 18 show respectively a front and a rear view of a 15,000-volt electrically controlled oil circuit-breaker made by the Hartman Circuit Breaker Co., of Mansfield, Ohio. The panel containing the oil switch, operating solenoids and overload relays, can be installed at any convenient point in the station and operated from the

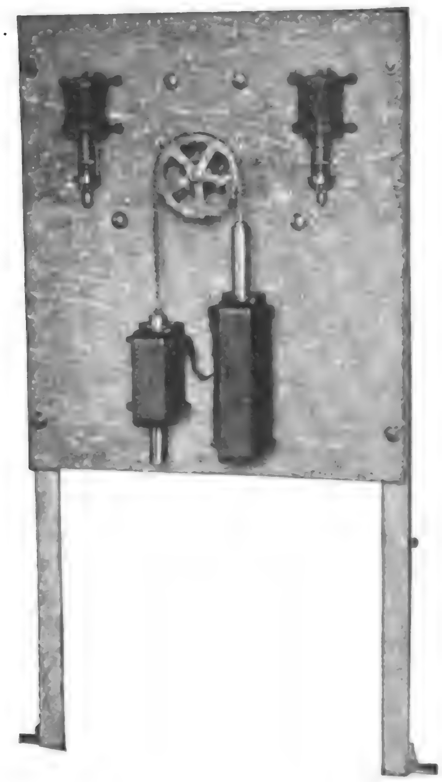


FIG. 17.—FRONT VIEW OF CIRCUIT-BREAKER.

main switchboard by means of a small double-throw switch. The rotary movement used in opening and closing the Hartman switch readily lends itself to solenoid control. The usual operating handle is replaced by a steel sprocket wheel. The link belt which engages the sprocket wheel is attached at one end to the movable core of the closing solenoid and at the other end to the core of the opening solenoid. The downward movement of the core of the larger solenoid effects the closing of the switch and the same movement of the core of the smaller solenoid effects the opening of the switch. The small double-throw switch for operating the indicating lamps on the main switchboard is located on the operating shaft back of the sprocket wheel. The operating current is derived from the exciters, a storage battery or any convenient source of direct-

current supply. The solenoids can be wound for any standard voltage. When an automatic switch is required the overload relays are placed on the same panel, and the operation of the plunger of either relay will close the direct-current circuit and effect the opening of the circuit-breaker. A combined overload and inverse time limit relay is shown in Fig. 17. The time limit operates on the vacuum principle, the admission of a smaller or greater quantity of air into the brass tube containing the plunger having the effect of retarding or accelerating the movement of the latter. On an ordinary overload the automatic opening of the circuit-breaker may be delayed for any desired period up

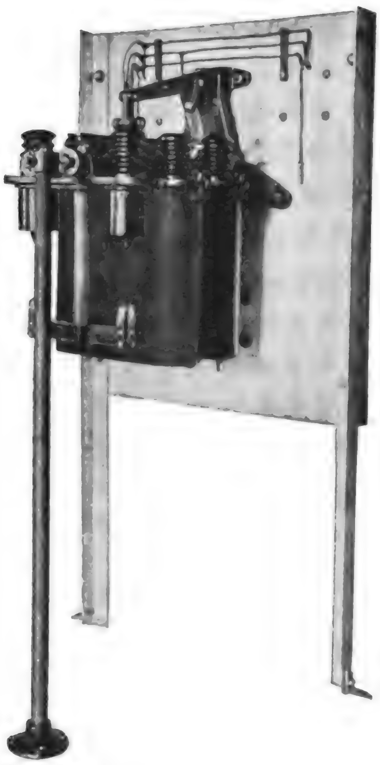


FIG. 18.—REAR VIEW OF CIRCUIT-BREAKER.

to 10 seconds. The heavier the overload, however, the quicker will be the action of the plunger, and an excessive overload or short circuit will cause the plunger to act almost instantly. The switch shown in Fig. 18 is a three-pole standard, type C switch, which is made for potentials up to 22,000 volts. The live parts of each pole are enclosed in a cell made of specially treated indurated fibre. The contacts are of the laminated, double-break type and the oil tanks are moulded in such a way as to isolate each breaking point.

DOUBLE-ENDED HORIZONTAL WATER-TUBE BOILER.

Fig. 19 shows the double-ended water-tube boiler built by the Parker Boiler Company, of Philadelphia, Pa. The drums are constructed in accordance with the very latest practice, using the best material and riveting of the highest efficiency. The diaphragm of ¼-in. steel plate is riveted to the shell and arranged to form a pocket at the front to collect the scale discharged from the tubes. The anti-priming valve is hinged to the diaphragm head and serves as a manhole for the lower chamber. The bottom of the drum below the level of the nipples leading to the elements forms the sediment pan or mud drum. An inverted angle with closed ends is placed along the bottom of the drum and over the blow-off opening, making the blow-off effective for its full length. The tubes are expanded into the junction boxes, which are like return bends, holding two tubes. This arrangement permits the free expansion of every tube without strain on any joint. The flexibility of the construction is such that the boxes can be separated several inches at any point for admittance to the baffles or for renewing a tube, giving sufficient opening to permit the removal of evaporating elements are two tubes wide, passing the water twice across the furnace at each level. The connection to the drum at the upper or induction end is made by an expanded tube entering an "inlet" box which supplies two elements, each having a brass non-return valve in the top junction box, and the lower end of each element is connected to the steam chamber by an independent upcast. The baffles to direct the course of the gases are made up of small fire tiles resting on the tubes. The illustration shows a 700 h.p. boiler fired at both ends with inclined stokers and equipped with a superheater. The working pressure is 200 lbs. The lower tubes are inclined to give space for the superheater,

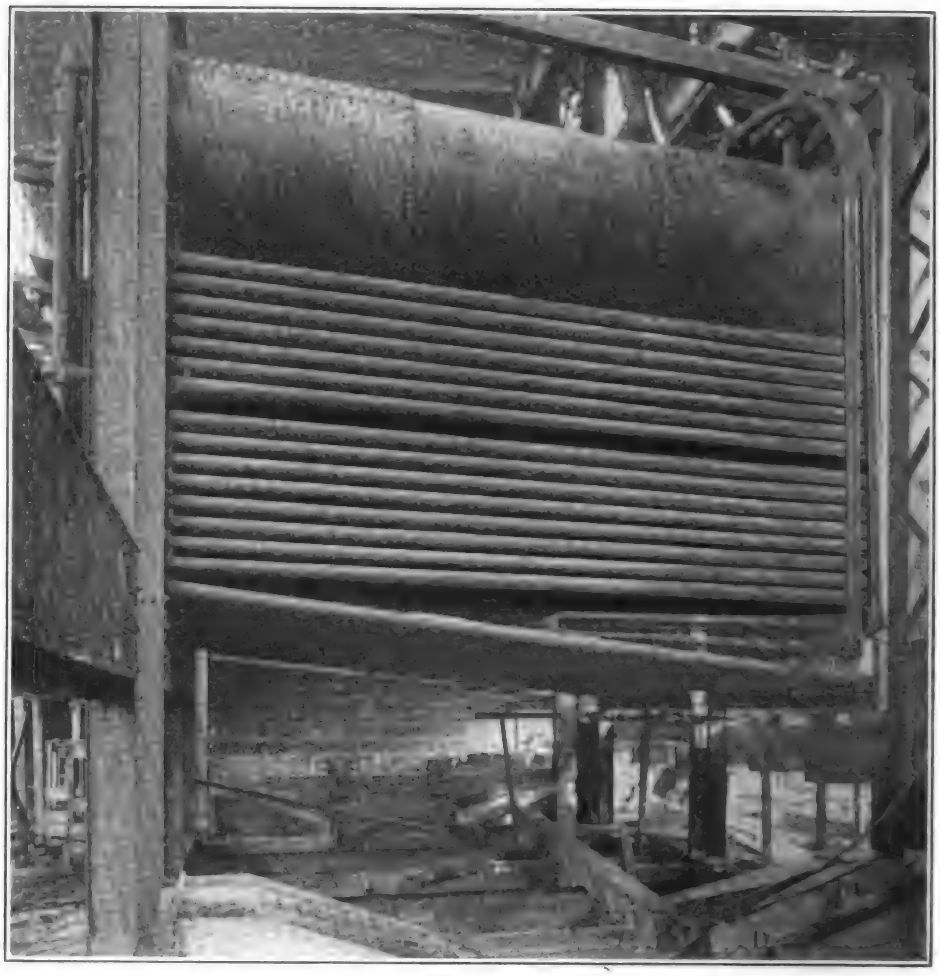


FIG. 19.—PARKER WATER-TUBE BOILER WITH SUPERHEATER.

18-ft. tubes in a 10-ft. fire room. Each tube is accessible for removal. In high boilers, the lower row of tubes is usually inclined, giving access to the baffles and lower tubes without lifting the boxes. The tubes above the top baffle form the feed element. The inlet end is connected to the drum with an expanded nipple, and the feed connection is made to the top rear junction box beyond the non-return valve. The flow in the element is forward and back alternately through each tube in the top row, then down to the next row, and so on, finally discharging through a vertical upcast into the rear drumhead above the diaphragm. A blow-off connection is made at the bottom end of the feed element, and water can be forced through the entire element under full boiler pressure. The lower or and as much heat can be passed direct to the superheater as desired. The heating surface is as follows: Economizer surface, 3,000 sq. ft.; evaporating surface, 4,000 sq. ft.; superheating surface, 375 sq. ft. The grate surface is 140 sq. ft. The boiler proper, without the economizer and with a single grate is rated at 400 h.p., but by doubling the grate surface it has been run up to 940 h.p. The addition of the economizer keeps the flue gases down to about 400°, and makes the economy very high for that rate of working. Aside from the economy in space obtained, the advantages claimed for this boiler are as follows: The scale can be removed from the tubes automatically while the boiler is in operation; the flexible construction permits the independent expansion of every tube; the combination of boiler

and economizer in one setting, with the downward course of the water and steam in the tubes, increases the efficiency of the heating surface by bringing the coolest water next to the coolest gases; the strong non-reversible flow make burnt tubes impossible, as distinguished from the uncertain circulation in inclined tubes; the inside circular hand-hole covers, held to their seats by the pressure, with conical ground joints, require no cleaning nor packing, and do not become leaky; and the separate chambers for steam and for water, with anti-priming valve between, make wet steam impossible.

THE "LOEW" CLOSED FEED-WATER HEATER.

It is a well-known fact that when water is heated in a tube, the center is not heated as rapidly as the outer surface of the water. Bearing this fact in mind the Loew Supply & Manufacturing Company, of Cleveland, Ohio, has designed the feed-water heater shown by Fig. 20 herewith, so that when water traveling through the tubes reaches the several ports at the top and bottom of the various sections the course of the water is changed, the water thoroughly mixed and the temperature thus equalized. The heater is also arranged to pass the water six times through the exhaust. Ample space for expansion after heating is allowed, so that friction from this cause is minimized. The cold water entering the water inlet is carried up to a double port at the top of the heater where its course is changed and the water mixed. It then passes down the second section of tubes through a cored passage to the port at the bottom where the same change is effected; the water passing through the third section, etc., to the final double port and down through the sixth section to the outlet. The heater is built of cast iron with straight seamless brass tubes. The top tube plate is free to move so as to allow for the expansion of the tubes when hot. A hand-hole is provided at the bottom of the heater for cleaning purposes, and when an open surface of the tubes for cleaning purposes is desired the top heads may be easily removed and the bottom unbolted and dropped down.

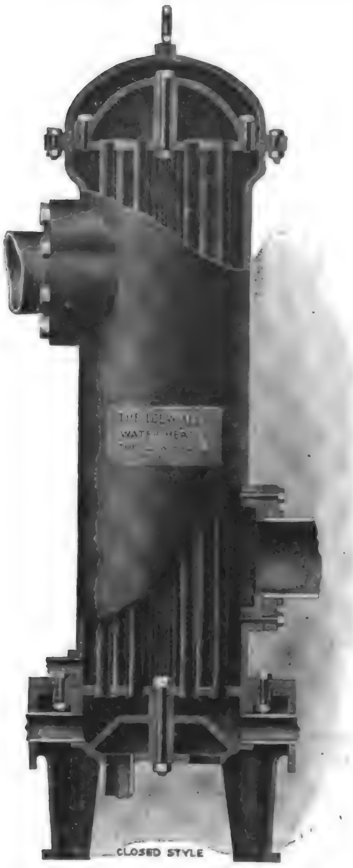


FIG. 20.—FEED-WATER HEATER.

ANNUAL MEETING OF WESTINGHOUSE MANAGERS.

The annual convention of the district managers of the Westinghouse Electric & Manufacturing Company was held November 13-16, at the general offices of the company at East Pittsburg. Mr. R. L. Warner, New England manager of the company, acted as chairman of the meetings, which were attended by the following representatives of the company: C. S. Powell, general agent, New York City; W. F. Zimmerman, representative, New York City; Maurice Coster, manager export department, New York City; W. C. Webster, assistant to second vice-president, New York City; F. H. Shepard, New York City; G. Pantaleoni, general southwestern manager, St. Louis, Mo.; J. R. Gordon, manager, Atlanta; H. H. Seabrook, manager, Baltimore; D. E. Manson, manager, Boston; C. W. Underwood, manager, Buffalo; T. P. Gaylord, manager, Chicago; C. W. Regester, manager, Cincinnati; G. B. Dusinberre, manager, Cleveland; J. E. Johnson, manager, Dallas; L. M. Cargo, manager, Denver; C. F. Medbury, manager, Detroit; T. J. McGill, manager, Minneapolis; C. A. Bragg, manager, Philadelphia; W. F. Fowler, manager, Pittsburg; D. E. Webster, manager, St. Louis; W. W. Briggs, manager, San Francisco; M. P. Randolph, manager, Seattle; Paul T. Brady, manager, Syracuse.


GROUP OF DISTRICT MANAGERS OF THE WESTIN GHOUSE ELECTRIC & MANUFACTURING CO.

At the opening session, which was held Monday morning, addresses were delivered by Mr. E. M. Herr, first vice-president of the company; by Mr. Frank H. Taylor, second vice-president, and by other officials. During the four days of the convention papers on topics of general interest were read by many of the officials and managers and by representatives of allied companies. On Wednesday evening the delegates and representatives of the local Westinghouse companies were entertained at the Hotel Schenley by Mr. Herr.

OBITUARY.

MR. BEAUCHAMP H. SMITH, second vice-president of the S. Morgan Smith Company, of York, Pa., died at his home in Los Angeles, Cal., on November 1, at the age of 36 years. Mr. Smith went to Los Angeles about five years ago for the benefit of his health and has since resided there in the hopes of a complete and permanent recovery.

MR. CHARLES CUTTRISS, inventor of the Cuttriss syphon recorder and head of the electrical department of the Commercial Cable Company, shot himself in his home in New York City on November 18, during a fit of temporary dementia caused by poor health. Mr. Cuttriss was a native of Bedford, England, and at the time of his death was 56 years of age. He is survived by a widow and three children. He graduated from Glasgow University, where he was a student and protege of Lord Kelvin, of whose submarine cable apparatus he made a special study for years. For twenty-one years, Mr. Cuttriss has been in the employ of the Commercial Cable Company and had traveled in the interests of the company almost everywhere the company's wires lead. He was a member of the American Institute of Electrical Engineers, the British Institute of Electrical Engineers and the New York Electrical Society.

PERSONAL.

MR. ROBERT F. McDOBLE, consulting engineer, of San Francisco, has severed his connection with the Abner Doble Company, in order to resume his individual practice.

MR. I. E. STOREY, the electric motor designer and inventor, has removed to Madison, Wis., in order to carry out to better advantage his work with the Northern Electrical Manufacturing Company.

MR. CLOYD MARSHALL has resigned his position as engineer of the Union Electric Light & Power Company, of St. Louis, and has become connected with the American De Forest Wireless Telegraph Company at St. Louis.

MR. CHARLES C. REMSEN, of the Sprague Electric Company, and Miss Mary Edna Fiske, were married in St. Paul's Methodist Episcopal Church, Newark, N. J., Nov. 1. Mr. and Mrs. Remsen went south on their wedding trip.

MR. CHARLES W. DODGE, who for the past ten years has been interested in engineering in New England, has entered the employ of Dodge & Day, of Philadelphia, and is at present giving his entire attention to extensive alterations and additions to the plant of the Link Belt Machinery Company, Chicago, Ill.

MR. V. C. GILPIN has opened offices at 120 Liberty Street, where he will represent the Tower-Burford knife switches and panel boards, the Monarch special lamps and "Arc Burst," and the Acme refilled incandescent lamps. Mr. Gilpin is widely known not only in the electrical supply trade of New York, but throughout the country.

MR. E. V. ENSIGN, after eleven years of continuous service as superintendent of the Leominster (Mass.) Electric Light & Power Company, has handed in his resignation to take effect in the near future. He will be succeeded by Mr. A. N. Clarke, of Boston, a practical business man, who is said to be well qualified to take charge of the plant.

MR. ALFRED E. BRADDELL, the well-known electrical engineer and electrical inspector of the Underwriters' Association of the Middle Department, Philadelphia, has resigned that position, and on December 1 joins the conduit department of the Sprague Electric Company in New York City. Mr. Braddell has a large circle of acquaintances in metropolitan and other electrical circles.

MR. J. B. DILLON, traffic manager of the Western Union office at Louisville, Ky., has been offered the position of chief operator for the company at Memphis, Tenn., and entered upon his new duties November 15. Mr. Dillon has been with the Louisville office for several years, starting as check boy and working his way up to his recent position of traffic manager. He has the reputation of being a fine operator and an expert electrician.

MR. H. D. ENDERISS has become associated with Mr. Louis J. Costa, 1229 Real Estate Trust Building, Philadelphia, Pa., and they will together represent the various firms whose interests in Pennsylvania and surrounding States have heretofore been looked after by Mr. Costa alone. Among the concerns represented by Messrs. Costa & Enderiss are the Jandus Company, the Chase-Shawmut Company and the Keystone Electrical Instrument Company.

MR. R. M. VAN VLEET, until recently associated with the Pittsburg office of the Cutler-Hammer Manufacturing Company, has been made manager of that company's Chicago office. Prior to his connection with the Cutler-Hammer Company, Mr. Van Vleet was electrical superintendent of the Columbia Iron Works, Port Huron, Mich., and his many years of practical experience in the electrical field have qualified him to efficiently look after the interests of his company in his new field.

MR. C. W. KELLOGG, who has had charge of the Brockton plant of the Edison Electric Illuminating Company, succeeding Mr. Preston Player, who was promoted fifteen months ago to the Blue Hill station, has been notified that Stone & Webster propose to transfer him to their plant in El Paso, Texas. There he will have charge of the station which furnishes light for the city and power for the trolley lines. Mr. A. F. Nelson will succeed him in immediate charge, and it is said that the Brockton and Lowell plants will be combined under the district management of Mr. N. T. Wilcox, of the latter city.

MR. A. P. PECK, who is well known in the Middle West as a successful salesman of electrical machinery, has joined the Allis-Chalmers Company and will hereafter be connected with the New York office of that company. He will travel throughout the New York district, giving particular attention to the sale of power and electrical machinery. Mr. Peck is an associate member of the American Institute of Electrical Engineers. He is a native of Chicago and was graduated from Purdue University, becoming identified immediately with the electrical engineering department of the Chicago World's Fair as assistant engineer of arc lighting. Since then he has represented successively the Westinghouse Electric & Manufacturing Company, the New York Belting & Packing Company, the Chicago Edison Company and the National Electric Company.

TRADE PUBLICATIONS.

POLYPHASE INDUCTION MOTORS. National Electric Company, Milwaukee, Wis.—Bulletin No. 359, describing the 25 and 60-cyle induction motors built by the company.

STEAM ENGINES. The Westinghouse Machine Company, East Pittsburg, Pa.—Catalogue W. M. 7004, describing in full the Westinghouse "Standard" engine. The general make-up of the catalogue is exceptionally good.

ELEVATORS.—A handsomely executed catalogue of standard size issued by the Otis Elevator Company of New York, illustrating and describing, in general, elevating machinery and apparatus manufactured by the company.

ELECTRICAL MEASURING INSTRUMENTS. The Simplex Company, Newark, N. J.—A pocket-size advance catalgue illustrating the complete line of portable and switchboard measuring instruments for both direct and alternating current circuits.

TOOLS. Brown & Sharpe Manufacturing Company, Providence, R. I.—A new edition of the company's Machinist's Tool Catalogue, devoted to tools too numerous to mention. The entirely new products of the company are enumerated on a colored insert.

TELEPHONES. Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y., and Chicago, Ill. — A pocket-size booklet telling briefly some of the advantages of a private telephone system and illustrating a few of the different styles of telephones built by the company.

HOISTING ENGINES.—C. W. Hunt Company, West New Brighton, N. Y.—Catalogue No. 058, devoted to "Hunt" steam hoisting engines. The engines described in the catalogue are unusually massive in construction, and especially designed for heavy duty in continuous service.

BELT - DRIVEN, DIRECT - CURRENT MACHINERY. Crocker - Wheeler Company, Ampere, N. J.—Bulletin No. 61, superseding Bulletin No. 46, devoted to Form D, belt-type, direct-current machines, the motors ranging in size from 10 to 275 horse-power and the dynamos from 9 to 225 kilowatts.

MECHANICAL DRAFT. B. F. Sturtevant Company, Hyde Park, Mass.—Pocket-size Bulletin No. 75, entitled "Mechanical Draft. What It is. What It Does." The difference between forced and induced draft is pointed out and illustrations are given of plants using both, the Sturtevant system of mechanical draft, of course, being used.

MEASURING INSTRUMENTS. Keystone Electrical Instrument Company, Philadelphia, Pa. —Publication No. XIII, illustrating and describing Keystone standard reading instruments for direct-current circuits in switchboard and portable types. These latter include voltmeters, ammeters, milli-volt and am-meters, ohmmeters, and volt-ammeters.

GRINDERS. Stow Manufacturing Company, Binghamton, N. Y.—A circular descriptive of the new heavy stationary or portable emery grinder, electrically driven, brought out by the company. Multi-speed is obtained through the Stow motor, which, as is well known, requires no controller or rheostat, speed variation being secured by changing the magnetic reluctance of the field.

STEAM TURBINES. General Electric Company.—A well-illustrated catalogue showing some representative installations of Curtis steam turbines which are briefly described in the titles. The first machine was placed in commercial service October 1, 1902. Curtis turbines now in daily commercial service have a rated capacity of over 135,000 kilowatts and an overload capacity of over 202,300 kilowatts.

BELT PREPARATIONS. Cling-Surface Company, Buffalo, N. Y.—A special publication entitled "The Effect of Preparations Applied to Belts," giving the results of some interesting tests made with various belt preparations at Cornell University. The comparative values of the various belt preparations on the market when tested under the same working conditions are given. The booklet is a decided addition to belting literature.

BUSINESS NEWS.

AMERICAN ELECTRICAL HEATER COMPANY, Detroit, Mich., has moved its New York offices from 35 Dey Street to 7 and 9 Warren Street.

O. S. WHITLOCK & CO., West Orange, N. J., have recently removed their factory from Newark to the above address, where they have a larger factory and much better facilities for handling their growing business.

AMERICAN ELECTRIC SIGN COMPANY, Boston, Mass., has removed from 133 Summer Street to larger quarters at 44 High Street, where it will have much better facilities for handling its increasing business.

THE LEE ELECTRIC LIGHT COMPANY Clarinda, Ia., contemplates entering the ice making and cold storage field, in connection with its electric light and power business, and would be pleased to receive catalogues and price lists from dealers in this class of machinery.

THE O. C. WHITE COMPANY, Worcester, Mass., suffered from a fire recently, which threatened the destruction of the entire property. The stock was badly damaged by smoke, water and chemicals, but the machinery and tools were all saved, though also somewhat damaged. The company, however, effected temporary repairs immediately and has been shipping orders as usual.

FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind., has moved its Boston office, under the management of Mr. J. Allan Smith, from 518 Exchange Building into more commodious quarters at 110 State Street, rooms 601-604 Plymouth Building. The old telephone number, Main 2044, is still retained. This change was necessitated by the large increase in busines transacted by this office.

THE LAGONDA MANUFACTURING COMPANY, Springfield, Ohio, announces that it has purchased two acres of ground, upon which will be constructed at once a cement block and steel plant. The building will be 200 feet long, 50 feet wide, and it is hoped to have it completed this fall. The company's present plant is quite inadequate, though it is now being run night and day to meet the demands of the trade.

DENISON MANUFACTURING COMPANY, Warren, Ohio, is bringing out a student's electric engine, which is said to run at variable speeds, either way, from 200 to 3000 r.p.m. Both speed and reverse can be changed by means of a controlling lever while the engine is in motion. The engine can be operated by either one or two dry batteries and will develop power enough to run small toys, belts, pulleys, etc.

G. M. GEST, the expert subway contractor of New York and Cincinnati, has been awarded the contract for the construction of a complete subway system at Chattanooga, Tenn., for the East Tennessee Bell Telephone Company. Active work on construction has been commenced and is to be rushed to speedy conclusion. This is the first conduit work installed in the city of Chattanooga, and the system will be a large one.

CHANDLER & TAYLOR COMPANY, Indianapolis, Ind., reports among recent contracts the following: Three engines for the Michigan Agricultural College at Lansing, Mich., of standard service enclosed self-oiling type for direct connection to Bullock generators; an engine of the same type for the N. Auth Provision Company, Washington, D. C.; three engines, one of 100 kilowatts and two of 50 kilowatts capacity, to the Sisters of Providence Charitable Institution, St. Marys, Ind.

PITTSBURG GAGE & SUPPLY COMPANY, Pittsburg, Pa., reports a material increase from month to month in the sales of White Star oil filters. Among rcent purchasers of this company's product may be mentioned: Wabash Clay Company, Veedersburg, Ind.; Lalance & Grosjean Manufacturing Company, Harrisburg, Pa.; Campbell & Wright, Tuskegee, Ala.; Gilmore & Davis Company, Tallahassee, Fla.; Driggs-Seabury Ordinance Corporation, Sharon, Pa., and the Schmulbach Brewing Company, Wheeling, W. Va.

ELECTRICAL TESTING LABORATORIES, New York City, in response to the demands of its clients, has installed a machine for testing some of the mechanical properties of conductors. The rated capacity of this machine, in the measurement of tensile strength, is 15,000 pounds, which is sufficient to break a No. 0000 hard-drawn copper wire. By this addition to its equipment the company now has excellent facilities for all such tests of wires and cables as are ordinarily required in electrical practice. These comprise measurements of conductivity, insulation resistance, dielectric strength, electrostatic capacity, tensile strength, elongation, elastic limit, etc.

KEYSTONE ELECTRICAL INSTRUMENT COMPANY, Philadelphia, Pa., announces that it has established agencies for the sale of its instruments, as follows: 170 Summer Street, Boston, in care of F. B. Smith; 114 Liberty Street, New York City, in charge of Arthur Organ; 1229 Real Estate Trust Building, Philadelphia, managed by Louis J. Costa; 1526 Park Building, Pittsburg, under the management of J. L. Merrill; 165 S. Canal Street, Chicago, which will be looked after by Wm. P. Crockett; Seventh and Hickory Streets, St. Louis, where the company will be represented by the St. Louis Electric Manufacturing Company.

AUTOMATIC ELECTRIC COMPANY, Chicago, Ill., is in receipt of a letter from the secretary of the Citizens' Telephone Company, Grand Rapids, Mich., which is a very satisfactory testimonial to the success of the company's automatic telephones. The telephone company reports a net gain of 829 telephones since January 1, 1905. A few weeks ago the exchange had 6,784 instruments in service, and it is expected to reach the 7,000 mark before the holidays. The automatic apparatus was installed January 9, 1904, displacing a manual telephone exchange with 5,094 telephones, leaving a net gain of 1,629 in approximately twenty months, despite an increase in rates.

AMERICAN BLOWER COMPANY, Detroit, Mich., is erecting a three-story addition to its plant. This is made necessary by the rapidly increasing business of the company, which is said to be partly due to the growing demand for its Type "A" enclosed vertical, self-oiling engine, which was placed on the market some two or three years ago. The building will be of steel and brick construction. The first floor will be devoted to the erection and testing of engines, for which the best facilities will be provided; the second floor will be used for storing engine parts and painting the completed engines, and the third floor will be utilized for storage purposes entirely.

THE HOLTZER-CABOT ELECTRIC COMPANY announces that it has decided to discontinue its New York offices after December 1. The company has been led to take this step, believing it to be in the interests of its patrons to deal direct with the head office; since the nature of its business involving, as it does, such a variety of engineering problems, makes direct dealing desirable if not essential. The management feels confident that this change will enable it to handle the business more expeditiously than in the past, and therefore to the greater satisfaction of its trade. All communications in the future should be addressed to The Holtzer-Cabot Company, Brookline, Mass.

ALLIS-CHALMERS COMPANY, Milwaukee, Wis., has been awarded contracts for a vertical triple-expansion crank and fly wheel pumping engine, with a daily capacity of 6,000,000 U. S. gallons against a head of 190 feet, by the Newport water works, Newport, R. I.; for a horizontal compound condensing engine, having a capacity of 1,500,000 U. S. gallons in 24 hours against a head of 290 feet, by the Metropolitan Water & Sewerage Board, of Boston; three centrifugal pumps, each with a capacity of 10,000,000 gallons daily, for the Massapequa pumping station, Borough of Brooklyn water works; and for the complete electrical and power equipment for the new municipal lighting plant shortly to be installed by the City of Alpena, Mich.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., reports having closed contracts for switchboards for the following places: Friendly, W. Va.; Sistersville, W. Va.; New Matamoras, Ohio; Laclede, Mo.; Long Lake, Minn.; Eureka, Payson, Richmond and Tooele, Utah; Preston, Ida.; Lowville, N. Y.; Louisville, Ky.; Attica, Ind.; Rochester, N. Y.; Varna, Ill.; Varich, Mo.; Bouton and Atalissa, Ia.; Leonard, Mich.; Stuttgart Kan.; Stromsburg, Neb.; Stelhensport, Ky.; Yates City, Robinson and Lakewood, Ill.; Holt, Mo.; Houlton, Me.; Bingham, Tremonton and Carland, Utah; Columbus, O.; Robinson and Lakewood, Ill.; Chillicothe and Harrisonville, Mo.; Fulton, Kan.; Jamestown, N. Y.; Spanish Fork, Utah; Tonopah, Nev.

THE CHICAGO & NORTHWESTERN RAILWAY COMPANY has established an Industrial Bureau, the purpose of which is to furnish reliable information regarding the many desirable locations along the Northwestern Line for new manufacturing enterprises. Through the territory reached by this line, fine water-power locations abound that may be supplemented by electrical energy developed therefrom; vast forests of hard and soft timber for all kinds of wood-working concerns, mineral wealth that provides the material for foundry and machine work, and coal fields are close at hand. This feature should prove of much benefit, not only to the railway company, but also to the communities along the line, and such of them as have commercial organizations will find ready co-operation by this department.

THE UNDER-FEED STOKER COMPANY OF AMERICA, Chicago, Ill., calls attention to recent shipments of Jones stokers to various points throughout the United States and Canada. Among others are several in the electrical field, the largest of which are as follows: The Georgia Railways & Electric Company, of Atlanta, is about to equip 1584 horse-power of Babcock & Wilcox boilers with eight stokers, this being a duplicate of an order placed some months ago; another shipment is that of twelve stokers for the equipment of 1,800 horse-power of Wickes vertical water-tube boilers in the plant of the Bartlett Illuminating Company, Saginaw, Mich.; the Consolidated Light & Power Company, Pluma, S. Dak., has also contracted for the equipment of 1,400 horse-power of Babcock & Wilcox water-tube boilers requiring eight stokers.

DE LA VERGNE MACHINE COMPANY, New York City, has established a branch agency at Atlanta, Ga., in order to take care of its increasing business in the States of North Carolina, South Carolina, Alabama, Florida and Georgia. This agency will handle the business connected with the three lines of machinery manufactured by the company, namely, refrigerating and ice-making machinery, "Hornsby-Akroyd" oil engines and Koerting gas engines. Mr. W. M. Hargreaves will be in charge of the Atlanta office, which will be located at 510 Candler Building. The company also reports that in addition to completing its contract for 40,000 of Koerting two-cycle, double-acting gas engines, it has recently received a contract for three 500-hp Koerting gas engines to be direct-connected to 325-kw, 550-volt direct-current Crocker-Wheeler generators for the Boston Elevated Railway Company. These engines will be put in operation about January 1.

POWER IMPROVEMENT COMPANY, Milwaukee, Wis., on the first of November took over the agency relations and business of George P. Dravo, and will continue to look after the interests in the Northwest of the De Laval Steam Turbine Company and the Foster Superheater. Associated with Mr. Dravo will be Mr. Andrew Pinkerton, of the American Sheet & Tin Plate Company. Mr. Pinkerton is a member of the American Institute of Electrical Engineers, the American Electrochemical Society and the American Society of Mechanical Engineers. Having been actively engaged for fourteen years in the adaptation of electricity to power and lighting purposes and also to chemical work, he can intelligently advise as to its proper application. The Power Improvement Company therefore tenders its services in the capacity of counselor or contractor for the improvement and installation of electrical and mechanical power equipment in line with the work previously carried on by Mr. Dravo.

THE PEERLESS ELECTRIC COMPANY, Warren, Ohio, calls attention to its electrically driven laundry machinery. A recent development is a Peerless motor direct attached to an extractor, which a number of the foremost manufacturers of laundry machinery are prompt to adopt. New installations by this company are individual motor equipment for the planing mills of Wallace Bros., Mahoningtown, Pa.; the Lawrence Lumber Company, New Castle, Pa., and the Bagley & Sewel Company, Watertown, N. Y.; also individual motors for the Hayworth Publishing House, Washington, D. C.; fifteen motors for Eaton, Hurlburt Company, Pittsfield, Mass., and sixty-two motors for the new plant of the Sherman Envelope Company, Worcester, Mass. Peerless high-frequency

alternating-current generators for laboratory use have been ordered by Cornell University, and by Mr. Joseph Murgas, of Wilkesbarre, Pa. The State University of Iowa has placed orders for laboratory transformers and motors, and the Massachusetts Institute of Technology has given an additional order for Peerless machines.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY reports an increasing demand for its alternating-current motors of the "CCL" type. A number of grinders in paper mills have recently been equipped with Westinghouse alternating-current motors, and the operation of the grinders so driven has been so entirely satisfactory, it is said, as to leave no question concerning the practicability and efficiency of this drive. The Brooklyn Heights Railway Company has placed an order with the Westinghouse Company for a substantial addition to its present equipment, consisting of 300 No. 101-B Westinghouse direct-current railway motors and 150 sets of controllers, the order for motors being in addition to one placed some months ago for 600 machines of the same type. The company has just perfected a portable pipe thawing transformer of 5 kilowatts capacity, also a choke coil to work in connection with standard 15 to 20-kw lighting or power transformers, thus making standard capacity transformers available for thawing purposes in winter. A new line of Westinghouse ceiling and floor-column fan motors will be on the market the coming season, for both direct and alternating current. These fans will have four blades and ball bearings, and be finished in black enamel and oxidized copper. The alternating-current fans will be of the induction type and the direct-current fans will be furnished with three-point switches.

B. F. STURTEVANT COMPANY recently sold for export to Porto Rico a complete forced draft equipment for burning bagasse, the refuse sugar cane which is there extensively used for fuel. Among other large and important orders being filled by the company are several for complete heating and ventilating apparatus for numerous school buildings throughout the country, the Aetna Cotton Mills, Union, S. C.; shops of the Pennsylvania Railroad, the Detroit Oak Belting Company, Detroit, Mich.; the car and machine shops of H. S. Kerbaugh, Altoona, Pa., containing over three quarters of a million cubic feet of space; shops of the Page Woven Wire Fence Company; Ancram Paper Mills, Ancram, N. Y.; besides others for special induced draft equipment for the American Woolen Company, Maynard, Mass.; economizers for the Singer Manufacturing Company, Elizabethport, N. J.; Springville Manufacturing Company, Rockville, Conn., and the Nashua Manufacturing Company, Nashua, N. H.; air washing apparatus to be installed in connection with the heating and ventilating system in the office building of H. K. Porter Company, Pittsburg, Pa.; complete equipment for a modern smithshop, consisting of the forges, a pressure blower, exhaust fan and a system of smoke and blast piping; complete exhausting arrangement for the grinding wheels of the Imperial Cutlery Company, Avondale, N. J.; also mechanical draft apparatus for the Illinois Central Railroad Company, Chicago, Ill.; Cleveland-Cliffs Iron Company, Ishpeming, Mich.; Jefferson County Jail, Louisville, Ky.; Eaton, Cole & Burnham, Bridgeport, Conn., and the U. S. Custom House, New York City.

CENTRAL STATION NEWS

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

ALABAMA.

ABBEVILLE.—The citizens are discussing the question of constructing an electric light plant.

GUNTERSVILLE.—The question of constructing water works and an electric light plant is reported under consideration.

FORT PAYNE.—The Alabama Cooperage Company, of Fort Payne, has petitioned the Council for a franchise to construct an electric light plant to furnish light for the streets, residences and business houses.

MOBILE.—Mr. H. B. Rockwell, of New York City, for ten years connected with the New Hampshire Traction Company, has accepted the position of general superintendent of the Mobile Light & Railway Company.

ARIZONA.

PRESCOTT.—The McCabe Water, Light & Power Company has been incorporated with a capital stock of $50,000 by H. A. Suttle and Hiram E. Todd, both of Peoria, Ill.

ARKANSAS.

SHERIDAN.—E. C. Laine, of Pine Bluff, is about to put in an electric light plant here.

GRAVETTE.—G. W. Dunbar is interested in the construction of an electric light plant, street railway and water works.

HOT SPRINGS.—It is reported that the Citizens' Electric Light Company is about to be incorporated with a capital of $200,000.

NORTH LITTLE ROCK.—A water works and electric light plant will be constructed at North Little Rock. C. J. Humphreys, 104 East Fourth Street, a member of the Water Works Commission, has charge of the work.

CALIFORNIA.

SANTA ANA.—The City Trustees have decided to call a bond election for the purpose of deciding upon a bond issue of $135,000, of which $60,000 will be expended in the construction and equipment of a municipal electric light plant.

SAN FRANCISCO.—The Rubicon Water & Power Company has been incorporated by G. S. Wall, A. S. McDonald, R. A. Jackson, George C. Davis and H. D. Jerrett, with a capital stock of $1,000,000. San Francisco will be its principal place of business.

MOUNTAIN VIEW.—A committee consisting of W. A. Clark, D. B. Frink and O. Becker has been appointed by the Board of Trade to take preliminary steps looking to the establishment of a municipal light and power plant at this place. Power is at present supplied by the United Gas & Electric Company, of San Jose.

GILROY.—Engineer Thirber, of San Jose, who was employed by the City Council to furnish an estimate of the cost of an electric lighting plant, has submitted an estimate calling for $14,500. This is somewhat in excess of the funds available, but the council has decided to advertise for bids for the construction of the plant according to specifications and for the material needed for transmission lines.

RED BLUFF.—George W. Bush, of Redding, has filed claims on 18,000 miner's inches of water in Battle Creek below the mouth of Baldwin Creek for the purpose of generating electric power. Water is to be conducted in a canal 25 ft. wide and 6 ft. deep, and in wooden pipes 10 ft. in diameter, for a distance of six miles on the north side of Battle Creek to the vicinity of Horseshoe Bend.

LOS ANGELES.—The contract for the lighting of the public streets has been let by the council to the Los Angeles Gas & Electric Company for a term of three years. The cost will be $75.60 a year for each light. The same company is now supplying the city's lights at a cost of $6.75 a month for each light. During the next three years 300 lights will be added every year, which will make the total cost for lighting for the three years about $500,000.

CALISTOGA.—The Calistoga Electric Light & Power Company has filed articles of incorporation and proposes to establish an electric lighting and power plant that will supply all of its needs and those of the big wineries in this vicinity. The articles also provide for the establishment of a gas plant. The capital of the company is $20,000. The directors are G. W. Cutler, E. L. Armstrong and Mrs. Edna Brown, of Calistoga, and District Attorney Raymond Benjamin, of Napa.

OROVILLE.—The Oro Water, Light & Power Company has completed the contracts for the equipment of its electric transmission plant at Pentz by ordering two "double overhung" Pelton impulse wheel units. A 1000-h.p. wheel is placed at each end of a shaft, with a 1000-kw. General Electric three-phase railway-type generator in the middle. There are two of these units to be operated under a head of 465 ft., transmitting power 16 miles to Oroville, where city lighting and power for operating gold dredges will be supplied. There is an ample water supply from the Feather River Canyon.

RIO VISTA.—J. S. McDonald, representing the Rio Vista Electric Light & Power Company recently asked to be granted the privilege of erecting poles on the streets and a lease on certain town property on which he wishes to build a power plant. Mr. McDonald stated that it was desired to begin work at once so as to finish as soon as possible, before the rains delayed them too greatly. The town has already been staked out for the poles, and the grounds laid out for the power house. The plant will be large enough to supply a town twice the size of Rio Vista, and is valued in the neighborhood of $20,000. It has been in use in another part of the State for about eight months, so is comparatively new.

SAN FRANCISCO.—The Stanislaus Electric Power Company has been organized with a capital of $10,000,000. There has already been subscribed some $6,000,000. The financiers of the new incorporation are Tucker, Anthony & Co., of Boston, Mass., and the Knickerbocker Trust Company, of New York. Mr. B. Thompson, of San Francisco, was the organizer of the company, and Leopold Wallach, of New York, is understood to have interested Eastern capital in the enterprise. Both Mr. Wallach and Leopold Michels, president of the San Francisco Coke & Gas Company, are heavily interested in the new power company. The company has been organized to furnish San Francisco with electric power, and will probably be allied with the San Francisco Coke & Gas Company. It is understood that work has already been commenced on the middle fork of the Stanislaus River. The plans of the company call for 30,000 electrical horse-power, and in addition to that, water power equivalent to 20,000 horse-power. Two large storage reservoirs are to be built which will take in about 1,500 acres. Enough timber land is to be purchased to provide for the lumber necessary in the construction of flumes and buildings.

COLORADO.

COLORADO SPRINGS.—The Stevison Electric Company has been incorporated, with a capital of $5000, by W. F. Stevison, Maggie Stevison and F. A. Blakeley.

ROCKVALE.—The council of Rockvale has granted the Arkansas Valley Electric Light Company a 25-year franchise to construct and operate an electric light plant.

LAMAR.—State Auditor Bent was in Lamar recently, and while here placed an order for an entire new equipment for the Lamar Electric Company's power plant. The total improvements contracted for will cost $10,000.

BUENA VISTA.—The Buena Vista Electric Light Company has leased its plant to W. P. Eyre, who for a number of years has had the management of the plant. He has already begun remodeling the works, having installed a 125-h.p. Leffel water-wheel. The old incandescent lights used by the city are to be replaced with twenty-one enclosed arcs.

LAS ANIMAS.—D. Kennedy, general manager of the Las Animas Electric Company, has made the city an offer to relinquish municipal management of the water works system and turn the same over to his company, who will operate it at a rate of three and three-tenth cents per thousand gallons of water furnished. It is the intention to do the pumping with an electric motor. This is a material reduction over the present cost to the city, but in case of any considerable growth in the consumption of water, would not be so desirable. The electric company, however, proposes to enlarge its plant and furnish a day current to local industries.

CONNECTICUT.

RIDGEFIELD.—The plans for the plant of the Ridgefield Electric Light Company have been approved and contracts will soon be let for the work.

GUILFORD.—Preliminary operations have been inaugurated for an electric light circuit to Madison for which an independent power house will be erected in the near future, the location of which is not definitely decided upon.

HARTFORD.—The entire electrical system of the city is about to be changed over from direct to alternating current, and all the power will be supplied from the new station at Black Rock. The company has gradually been changing over the system until now only the central section of the city is operated from the steam station in Chestnut Street. When the entire system is changed it will mean the abandonment of the Chestnut Street power station as a source of supply.

NEW HAVEN.—The committee on public lighting adopted a resolution to be presented to the Board of Aldermen that the committee be instructed to confer with the United Illuminating Company, which has been furnishing the lights, and obtain terms for the renewal of the existing contract for electric arc street lights, expiring December 31. The resolution also instructed the committee to hold a public hearing in the matter and report for the consideration of the Board of Aldermen a draft of the contract between the city and the United Illuminating Company.

WINDSOR LOCKS.—Mr. Burdett Loomis, of Hartford, representing a syndicate of Philadelphia capitalists, has acquired a controlling interest in the capital stock of the Windsor Locks Electric Lighting Company, the price for the control being $200 a share. The company has a capital stock of $20,000, and it also has outstanding a $30,000 issue of 4½ per cent bonds, which mature in 1922. The company pays a regular dividend of 6 per cent, and it recently declared an extra of 4 per cent. It is expected that the new owners will expand the plant and operate it for power and light, both night and day. A gas plant will probably be added to the equipment at an early date.

CUBA.

HAVANA.—Mr. Edmund G. Vaughan, president of the National Bank of Havana, has been elected president of the Havana Electric & Gas Company.

DELAWARE.

DOVER.—The Metropolitan Gas & Electric Company, of Chicago, has been incorporated with a capital of $12,000,000, to furnish natural and artificial gas. The incorporators are Jos. Markley and Geo. F. Goodnow, of Chicago, and Harry W. Davis, of Wilmington, Del.

FLORIDA.

JACKSONVILLE.—The Allis-Chalmers Company, of Milwaukee, Wis., has secured the contract for two 500-kw. turbo-generators, with the necessary equipment, at $36,135.

GEORGIA.

TALLAPOOSA.—It was decided at a recent election, held for the purpose, to bond the town to the amount of $100,000 for the establishment of an electric light plant.

ROME.—R. L. West, of Atlanta, it is reported, is one of the promoters of a company which proposes constructing an electric plant on Etowah River, between Rome and Cartersville to furnish electricity to run machinery and for other purposes. The company has a capital of $400,000.

ATLANTA.—According to a quoted statement of Forest Adair, vice-president of the Atlanta Water & Electric Power Company, there can be no reopening of the question of the franchise of the company with the State, Mr. Adair claiming that the matter has been settled by arbitrators and that the proposed reopening of the matter by submission to another board is without precedent, as far as he knows. The state comptroller will, however, insist upon the collection of taxes on a valuation of nearly half a million dollars.

ATLANTA.—The Southern Light & Power Company has decided to issue $500,000 bonds, to be used for the construction of an electric plant in or near Atlanta, for the purpose of furnishing power in Fulton and DeKalb counties. The company has located the site of its building in Atlanta and has purchased the property upon which its offices will be erected. The building will be located on Edgewood Avenue, near the corner of Courtland Street. The property, which has a frontage of 85 feet on Edgewood Avenue and a depth of 85 feet, was purchased for $5,000 cash. General A. J. Warner, president of the North Georgia Electric Company, and also interested in the Southern Light & Power Company, states that the latter company was organized to furnish and distribute electric current for light and power in the city of Atlanta. It has contracted with the North Georgia Electric Company for electric current to be supplied continuously to any extent that may be required. The North Georgia Electric Company, and companies allied with it, now control water powers in the vicinity of Atlanta approximating 100,000 horse-power. Two powers on the upper Chattahoochee have already been developed and others are in process of development, and the power developed is ready for transmission to Atlanta as soon as the transmission line now being constructed is completed. The wires for this line will be carried on substantial steel towers instead of wooden poles.

ILLINOIS.

MONMOUTH.—The Monmouth Gas & Electric Company is reported to have completed plans for an electric light plant.

WATSEKA.—Foundations have been laid for an addition to the electric light plant, 25 x 75 feet. It will be a brick structure.

NASHVILLE.—K. H. Steinhauser has purchased the Nashville electric light plant from the present owners, the deal being closed at East St. Louis by C. M. Foreman.

PARIS.—The Paris Gas & Electric Company has been reorganized with Wm. Hunter, of Paris, as president, and J. C. Shumway, of Taylorville, secretary, and will issue $20,000 bonds to make improvements.

PANA.—The Pana City Council has granted the Pana Gas & Electric Company a franchise to lay pipes through the streets and alleys of the city. The city also closed a contract with the company to light the city at $72 a year for each lamp.

QUINCY.—The Quincy Gas, Electric & Heating Company, at its recent annual meeting, elected A. L. Stevens, of Detroit, Mich., president; J. T. Lynn, F. K. Pelton, M. G. Borgman, all of Detroit, respectively, vice-president, secretary and treasurer. The officers and Dr. J. H. Rock, of Detroit, and W. A. Bixby and Dr. J. H. Rice, of Quincy, were elected directors.

HOOPESTON.—The City Council has granted a fifty-year franchise to Mr. Charles J. Wakeman for a gas and electric lighting plant. It is proposed to rebuild the electric plant and to put in gas works. Mr. Wakeman is the president and manager of the present Hoopeston Electric Lighting & Heating Company, which has Westinghouse and Fort Wayne apparatus for lighting and a day power circuit.

STREATOR.—The People's Light & Railway Company and the Streator Gas & Light Company have been purchased and the two properties combined by the recently incorporated Illinois Light & Traction Company. The new corporation is capitalized at $400,000, and, in addition to extending the local lines will build an interurban road connecting Streator and Ottawa, Ill. Negotiations are pending, it is said, for the purchase of the street railway plants and the lighting plant at Ottawa.

INDIANA.

VINCENNES.—John Fries, Wm. Bolk and H. H. Osterhage are heading a company to build a large ice plant and cold-storage house. The company will also, it is understood, install an electric plant.

GENEVA.—W. R. Thurston has obtained a franchise to build a modern electric light plant here. Mr. Thurston has organized a stock company and proposes to have the plant in successful operation in a few months.

SHELBYVILLE.—The electric light plant of Shelbyville has been transferred to the Citizens' Water & Light Company by direction of the United States Court. A mortgage for $50,000 on the plant and property has been given to the United States Mortgage & Trust Company. The company is now proposing to make extensive improvements and install some modern machinery in the plant.

EVANSVILLE.—The Evansville Gas & Electric Light Company has entered into a contract to furnish electric power for three of the interurban roads running into Evansville, with a possibility of securing a similar contract for the fourth line. Extensive additions are being made to the company's plant in order to supply the needed power. The company estimates that it will expend upwards of $130,000 on these improvements.

TERRE HAUTE.—Municipal ownership of the electric light plants and other public utilities is the paramount issue in the campaign just closing in the cities of Terre Haute and Fort Wayne. Both political parties in each city are pledged to municipal ownership of such utilities, but differ widely as to the best method of bringing it about. The new cities and towns law of Indiana provides that such questions shall be submitted to a vote of the people.

INDIAN TERRITORY.

BROKEN ARROW.—A company is being organized to install an electric light plant here.

LEHIGH.—The Lehigh City Council has granted a franchise for electric lights and power to the Consumers' Ice Company, who will install the necessary plant at once.

FORT GIBSON.—A charter has been granted at Muskogee to the Fort Gibson Light & Traction Company, incorporated with a capital of $25,000. J. H. Nakdimo, of Fort Gibson, is president.

DAVIS.—W. P. Bullock is engineer in charge of the construction of an electric light and gas plant for J. B. Dickinson at this point. Mr. Dickinson has a 20-year franchise for furnishing electric lights and gas.

IOWA.

LE GRANDE.—The citizens have voted to establish a municipal lighting plant.

BURT.—The citizens of this city have voted for an electric light plant and a water works system.

INDEPENDENCE.—The city officials are said to be considering improving the water works and electric light plants.

ROCK RAPIDS.—Work on the new lighting plant is now being pushed and it is expected the plant will be completed very shortly.

KANSAS.

OSAWATOMIE.—W. H. Murphy has been granted a franchise to install an electric light plant here.

GALENA.—The Galena Electric, Gas & Power Company has been incorporated with a capital of $100,000.

GEARY.—The Geary Electric Light & Power Company has been incorporated with a capital of $5,000. Directors: Chas. F. Dyer, I. J. Robb and J. M. Robb, all of Bridgeport.

CHERRYVALE.—W. R. Morrow, proprietor of the electric light and power plant at Peru, is making preparations to install a plant here. He has a franchise from the city.

LA HARPE.—S. A. Gard, of Iola, has made a proposition here to the City Council to light the town. Wm. Turner, of this place, has also made a similar proposal. The plan of the latter is to operate the light plant in conjunction with the ice plant.

HUTCHINSON.—Two 500-kw. steam turbines will be furnished for the Water, Light & Gas Company by the Westinghouse Company. These will operate with dry saturated steam at the throttle of 10 pounds pressure and 28-inch vacuum. The 60-cycle generators will deliver two-phase current at 2,200 volts.

KENTUCKY.

MOREHEAD.—The City Council is reported to have granted J. E. Davidson a franchise to light the city.

OAKDALE.—The American Electric Lighting Company, a concern recently incorporated, has secured a contract from the board of trustees of Oakdale to furnish lights for that suburb for a term of five years.

NEWPORT.—The contract for public lighting at Newport will expire within a short time and the City Council is considering the matter of renewal. The Union Heat & Light Company has had the contract for some years.

PADUCAH.—Joseph L. Friedman has been chosen president of the Paducah Light & Power Company. This company was incorporated following the recent merger of the light and traction interests in Paducah, brought about by the sale of the street railway, gas and heating properties to Stone & Webster, and is capitalized at $450,000.

SPRINGFIELD.—The Springfield Water & Electric Light Company (Incorporated), contemplates enlarging its lighting plant. They now have two 100-h.p. boilers, one Chandler & Taylor automatic engine, and one 60-kw. Wiley generator belt-connected. For the new plant they want a 125 to 150-h.p. tubular boiler, a 100 or 125-kw. direct-connected generator, and a 125 to 150 h.p. direct-connected engine of good make. It is proposed to reinforce all the main lines and to build a new one in the city. They have now from the station four No. 0 wires to the central part of the city. Other small changes are contemplated. Mr. H. B. McElroy is the superintendent and manager of the company.

LOUISIANA.

WINFIELD.—J. T. M. Hancock, of Rustin, La., has secured the contract to put in an electric light system here.

ABBEVILLE.—The Town Council and water works committee of this city at a recent meeting informally discussed the water plans submitted and the advisability of acquiring or constructing an electric lighting plant in connection wtih the system.

MAINE.

DEXTER.—The Dexter Electric Light Company has passed into the control of N. Curtis Fletcher, of Boston. It is understood that the service will be extended and improved.

GREENVILLE.—The Greenville Light & Power Company is constructing a new and larger electric plant a short distance south of the outlet of Wilson pond, about three miles east of Greenville.

SANFORD.—Advices state that Mr. W. E. Davis, of this city, has been appointed electrical engineer of the Atlantic Shore Line Railway Company and also the Alfred Light & Power Company, succeeding in the former position C. E. Sawyer, resigned. Mr. Davis still retains his connection with the Sanford Mills.

BANGOR.—Two large water power projects are now interesting the people of Maine—one at Sanford, on the Mousam River, now well under way, and the other at Ellsworth, on Union River, soon to be undertaken. At Ellsworth, where most of the very considerable power afforded by the falls of Union River is now idle, owing to the decay of the lumber manufacturing industry there, a corporation known as the Bar Harbor & Union River Power Company proposes to build two dams, each about 700 feet in length and sixty feet high from base to crest, and developing each about 4,500 horse-power—the lower dam for power purposes only and the upper dam for storage and power. It is proposed to build the upper dam first, beginning in January next, with a crew of 300 men, with the expectation of completing the structure in one year. The lower dam will be completed within two years. The power to be developed will be for distribution over a wide area, including Bar Harbor and other places in Hancock County. The dam now in process of construction on Mousam River is to be 40 feet high and 800 feet long, and will cost about $100,000. It will contain about 15,000 cubic yards of masonry. About 600 acres will be covered to the depth of 18 feet by the back flow, making a fair-sized lake. The dam, which is to be completed January 1, 1906, is being built for the purpose of storing water for the power plant of the Atlantic Shore Line Railway Company. The company uses, with its present equipment, about 750 horse-power. The new dam will develop 3,000 horse-power, and the surplus, over the railway company's requirements, will be sold for manufacturing purposes. Loring M. Farnum & Company, of Boston, are the contractors.

MARYLAND.

HAGERSTOWN.—The receipts from the municipal electric light plant for September were $1,409.23, against $1,077.38 last year.

HAMILTON.—The Hamilton Water, Light & Power Company has been incorporated with a capital of $35,000, to supply water and light to Hamilton and Lauraville.

MASSACHUSETTS.

AMHERST.—The Amherst Gas & Electric Light Company will extend its service to West Pelham.

HAVERHILL.—The Haverhill Electric Company has petitioned the city to share the expense of placing its wires underground.

REVERE.—Mr. C. F. Chisholm has been appointed superintendent of the Suburban Gas & Electric Company, which has a large electric light plant here.

QUINCY.—A petition is reported to have been presented to the City Council, asking that the city take measures to secure by purchase a municipal gas or electric light pant.

PITTSFIELD.—The Great Barrington Power Company has awarded to the Stanley Company, of this city, the contract for generators and electrical equipment. The contract amounts to about $13,000.

WINCHESTER.—The Edison Electric Illuminating Company has lately taken over the business of lighting the streets and houses of Winchester, which service was formerly performed by the Woburn Light, Heat & Power Company.

FALL RIVER.—The Fall River Electric Light Company is reported to be preparing plans for a power station to be located on the easterly shore of Taunton River. Harry Bottomley, superintendent, Fall River.

FITCHBURG.—The committee on fuel and street lighting reported an agreement with Fitchburg Gas & Electric Light Company to furnish incandescent lights in all city buildings at 12 cents per kilowatt-hour, a cheaper rate than is now paid.

LEOMINSTER.—H. D. Jackson, of Boston, it is reported, has been engaged to superintend the improvements which the Massachusetts Lighting Company intends making to the plant of the Leominster Electric Light & Power Company, on Mechanic Street.

SALEM.—The street lighting contract expired the first of October, but as it contained a provision that it might be continued for six months without a new contract, there is no danger of the city being obliged to pay an extra price or going without lights before April 1, at least. The committee on street lighting is collecting data of what other places are paying for lights and the quality of the light, and proposes to place the whole matter before the City Council with the figures offered by the local company. There is a strong element in the Council in favor of returning to the open arc system, as it is claimed that the city was better lighted under that system and the apparent saving made by the change has been offset by the increased number of lights required.

MICHIGAN.

IRON RIVER.—The citizens have voted to issue $30,000 bonds for constructing an electric light plant and the rebuilding of the water works.

MORRICE.—The electric lighting plant owned by Sutton & McKay has been sold to John Hubert, of Lansing, and Edward Hubert, of Farmington.

LUDINGTON.—The County Board of Supervisors has granted to the Pere Marquette Light & Power Company a permit to erect a dam on the south branch of the Pere Marquette River in Mason County. J. H. Cotton is president of the company and George S. Root, vice-president. It is understood that the company intends to furnish power and light to Hart, Scottsville, Custer, Pentwater and other towns. It is said that a 30-foot fall can be secured with a very short dam.

DETROIT.—The Onaway Light & Power Company, which proposes to supply a number of towns in Cheboygan County, and has already a well-equipped plant in operation, at its recent annual meeting elected W. W. Vaughan, of West Branch, president; George J. Robinson, of the Onaway Banking Company, vice-president, and H. H. Vaughan, secretary and treasurer. The latter is also manager. The company has put out a bond issue of $25,000, with the Detroit Trust Company as trustee of the mortgage.

KALAMAZOO.—The Ceresco dam, being built by the Commonwealth Power Company, of this city, will be completed about December 15. Next to the dam at Allegan, owned by the same company, this dam will be the largest in the State, and will cost about $150,000. The power derived from it will supply several electric roads, as well as many cities and villages. The Commonwealth Company has contracted to furnish power to operate the Jackson & Lansing electric road. When this line is completed, it is stated that the company will furnish power for the Lansing & St. Johns and Lansing-Haslett Park lines, in addition to supplying manufacturers with power.

GRAND RAPIDS.—The Grand Rapids-Muskegon Electric Water Power Company has filed its acceptance of the franchise as amended recently by the Common Council of Muskegon. The amended franchise provides that a yearly franchise fee be paid the city and that consolidation with any other corporation makes the franchise void. Wires in certain streets must be placed underground. The contract has been let for the erection of a concrete power sub-station for the company. The building will be located at Muskegon Heights and will cost about $6,500. The company expects to deliver power in this city and Muskegon by February 1. The contract for a concrete sub-station here has been let.

GRAND RAPIDS.—The Cadillac Water & Light Company has been purchased by Grand Rapids and Cadillac investors and reorganized with a capitalization of $200,000. An authorized bond issue of $120,000 has also been arranged for. The bonds are to provide for the purchase and improvement of the property, which consists of the water and electric light plants in Cadillac, which have been in operation for a number of years under the ownership of W. W. Cummer. A meeting of the stockholders was held and these directors elected: L. H. Withey, Amos S. Musselman, Edward Fitzgerald, Claude Hamilton, Henry Sullivan, W. H. Gay and W. H. Anderson, Grand Rapids, and F. A. Diggins and Henry Knowlton, Cadillac. The officers are: William H. Anderson, president and treasurer; Edward Fitzgerald, vice-president, Grand Rapids; N. V. Gerrish, secretary, and George Westover, manager, Cadillac.

MINNESOTA.

ANNANDALE.—The Council, it is stated, is considering the construction of a lighting plant.

MINNESOTA CITY.—The Minnesota Light & Power Company is reported to be contemplating the enlargement of its plant.

MANKOTA.—The franchise of the Mankota & St. Peter Railway & Lighting Company has been extended to February 12, 1906. By that time the franchise of the Willard company also expires and one or the other will then be granted an extension.

NORTHFIELD.—The Northfield Light, Heat & Power Company has sold its plant to the Cannon Falls Electric Light Company, who will operate the plant by power transmitted from the dam to be built across Cannon River, one mile west of the falls.

MINNEAPOLIS.—At the special election held recently the proposition to issue $35,000 bonds for the building of a municipal lighting plant was

carried by a large vote. The result was 628 to 123. This means the city will build and operate its own plant instead of awarding the contract for lighting to a private company.

OWATONNA.—W. F. Wilford, in charge of the operating department of the Owatonna Gas, Electric & Heating Company, has been made local manager of the company to succeed W. A. Stanton, who resigned in order to devote his entire time to the management of the Owatonna exchange of the Northwestern Telephone Exchange Company.

DULUTH.—Work has been started on the new distributing plant for the Great Northern Power Company. The contract, amounting to $100,000, was recently awarded to J. W. Hilliard, and the structure is to be completed by next May. It will be five stories high, with a frontage of 72 feet on Fifteenth Avenue and 144 feet on Michigan and Superior Streets.

MINNEAPOLIS.—The Stillwater Gas & Electric Light Company held its annual meeting recently. E. L. Hospes was re-elected president; J. H. Brown, of Chicago, vice-president; J. G. W. Johnson, secretary and treasurer. The company decided to make a number of improvements next season, including the erection of a new building in which electricity will be generated when it is impossible to secure the desired current from the company's plant at Apple River. N. N. Johnson has resigned as superintendent of the company's plant.

MISSISSIPPI.

BYHALIA.—R. D. Berry is installing an electric light plant here.

STARKVILLE.—Bonds to the amount of $8,000 have been sold for extending the water and light plant.

SHUBUTA.—The Shubuta Light & Water Company has been incorporated with a capital of $5000 by B. Hutchins, A. Bond and others.

CLINTON.—A resolution has been adopted by the Mayor and Board of Aldermen, authorizing the issue of $2,000 bonds for the purpose of extending the electric light and water works systems.

MISSOURI.

ELDON.—N. E. Harvey has asked for a franchise for the putting in of an electric light plant here.

JOPLIN.—The Joplin Electric Light & Power Company has been incorporated with a capital of $75,000.

TRENTON.—The electric light company of this city is negotiating to furnish light to several of the neighboring towns.

PLEASANT HILL.—The Pleasant Hill Hotel, Light, Power & Water Company has been incorporated with a capital stock of $40,000.

BOWLING GREEN.—The Pike County Light & Power Company has been incorporated with a capital stock of $7,000. Noah H. Ledford is among the incorporators.

INDEPENDENCE.—The City Council is reported to have granted a franchise to the General Light, Heat & Power Company, subject to the approval of the citizens.

ST. LOUIS.—Mr. Cloyd Marshall has resigned his position as engineer in the power department of the Union Electric Light & Power Company, and become connected with the American De Forest Wireless Telegraph Company here.

ST. LOUIS.—The written acceptance of the General Service & Development Company of the terms imposed in its franchise, granted by the county court, has been filed at Clayton. This company owns an electric plant at Brentwood, and recently purchased the electric plant and contracts of the West St. Louis Water & Light Company, which is supplying a part of St. Louis County.

MONTANA.

HELENA.—Mr. C. E. A. Carr has been appointed manager of the Helena Light & Railway Company, succeeding Mr. Howard S. Reynolds, who returns to New York.

HELENA.—The Helena Power & Transmission Company has secured the right of way between Butte and Anaconda and the stringing of wires has begun. The company will furnish power for the concentrator at the Washoe smelter and indirectly to the street car company.

LIVINGSTON.—Two carloads of machinery for the new electric light plant have arrived. The power house is 50x100 feet in area. It is expected that the equipment will soon be installed and the plant ready for service.

HELENA.—The Wisconsin Bridge & Iron Company, of Milwaukee, Wis., has secured the contract to construct a steel dam near Helena, for the Missouri River Power Company. The dam will be 630 feet long, 70 feet high and capable of developing 10,000 horse-power.

DILLON.—The Dillon Electric Light & Power Company has begun the reconstruction of its entire system in this city. The steam plant is to be improved at a cost of $6,000 and the transmission line between the plant and the city, which now consists of No. 8 copper wire, is to be replaced by No. 4 copper wire. The total cost of the improvements is estimated at $10,000.

NEBRASKA.

ANTELOPE.—Work is being pushed along rapidly at the city's water and lighting plant.

BROKEN BOW.—This city is considering the establishment of an electric light plant.

LINCOLN.—The Chickasha Light, Heat & Power Company has been incorporated with a capital stock of $125,000.

YORK.—There is reported to be a movement here among the citizens looking to the construction of a municipal electric light plant.

FREMONT.—It is stated that it is proposed to install three new boilers and make other improvements at the municipal electric light plant.

FREMONT.—S. F. Stiles, city clerk, writes that about $5000 will be expended for improvements to the electric light plant. J. H. Mathews is superintendent.

FRIEND.—A number of citizens have secured a franchise and will install an electric light plant here.

AUBURN.—The Auburn City Council has entered into a contract with the Auburn Mutual Lighting & Power Company to light the streets, lanes and alleys of the city for a period of five years.

OMAHA.—The contract department of the Omaha Electric Light & Power Company announces that it has closed a contract with J. L. Brandeis & Sons to furnish light and power for their new store building. The contract is the largest ever closed by the company. It calls for approximately 400 arc and 7,000 incandescent lamps, and motors to operate the nine passenger and four freight elevators which will be installed in the building.

KEARNEY.—Col. F. W. Blees has disposed of his stock in the Northeastern Electric Heat & Power Company and retired from the business November 1. The new owners of the company are gentlemen who are largely interested in like enterprises in various places and are thoroughly experienced and have ample capital. The name of the company remains the same. William E. McCully, of Macon, Mo., is secretary, treasurer and general manager of the company. He will spend about half of his time in this city, notwithstanding his extensive interests elsewhere. He is secretary, treasurer and general manager of the following corporations: Macon Gas & Electric Light Company; Marshall (Mo.) Electric Light & Power Company; Palmyra (Mo.) Light & Water Company. The new president of the company is Thomas E. Wardell and the vice-president is Fred. H. Tedford. The resident manager will be S. J. Duncan. L. E. Watson, who has been manager of the plant under the ownership of Col. Blees has accepted the position of manager of the Beatrice (Neb.) electric plant.

NEVADA.

GARDNERVILLE.—A. C. Pratt has secured enough capital to carry out his electric power plant project on the Carson River.

RENO.—A movement is being made by the City Council toward the municipal ownership of the holdings of the Reno Power, Light & Water Company, and it is believed that some such deal will be consummated in the near future.

GOLDFIELD.—The California-Nevada Mining, Milling & Power Company is said to have secured all the water rights along the Pine Creek in Inyo County, Cal., and will erect an electric power plant near Alvord, Cal., from which point a transmission line will be constructed to the Bullfrog mining district at a cost of about $150,000.

RENO.—W. B. Arnett, a mining engineer of this city, has just taken up a valuable water appropriation for power purposes, his dam site being located one mile below Vista and six miles east of Reno on the Truckee River. Six years ago the same site was taken up by different parties, but Arnett claimed they had forfeited ownership by failure to develop it and the same view has been taken by the state engineer, Henry E. Thurtell, who granted Arnett's petition for an appropriation. He has secured all the water in the river at that place and says he has an average flow sufficient to generate 3,000 horse-power. Mr. Arnett has secured ample backing and next April will begin the erection of a $100,000 power and lighting plant with which to supply electricity to Reno and Sparks. He will begin work on the construction of a seven-mile ditch and flume at once.

NEW HAMPSHIRE.

NEWPORT.—The Sunapee Electric Light & Power Company, whcih is now operated by the Newport Electric Light Company, has just completed the work of rebuilding its lines. A 24-hour service will now be given.

NEWMARKET.—W. H. C. Follensby, of Exeter, has been appointed receiver of the Newmarket Electric Light, Heating & Power Company by Judge Stone. The appointment was in answer to the petition of the minority stockholders of the company, which alleged that the affairs of the company were being mismanaged by President J. W. Burnham, of Durham, who was the majority stockholder, and that the company was insolvent. Further, that $15,000 of the bonds of the company had been fraudulently issued by the president, and asking that W. E. Barrett, of Boston, president of the Union Trust Company, be asked to explain how he had come into possession of the bonds, which the latter did. Mr. Follensby has furnished $5,000 bonds.

NEW JERSEY.

PERTH AMBOY.—C. D. Boynton, secretary of the Citizens' Electric Light, Heat & Power Company, writes that it is proposed to construct an electric light and power plant.

NEWARK.—The Cape May electric light system is to be extended to Rio Grande, seven miles away, supplying light to the villages along the route.

PLEASANTVILLE.—A contract has been let for a 250-h.p. engine for the local electric light plant.

NEWTON.—The authorities of Newton have entered into a ten-year contract with the Newton Gas & Electric Company to furnish arc lights for $72.50 per lamp per year, and incandescents for $24.

NEWARK.—A special committee has reported to the Newark board of works that an electric light plant could be established at a cost of $125,000, which would light the streets at about one-half the present cost. The board of works has asked the City Council for an opinion on the city's right to build such a plant under present laws and will, if necessary, ask authorization from the State Legislature.

WASHINGTON.—A sale of the Washington Electric Light Company has just been effected by the Gas & Electric Development Company, of Philadelphia, which will also have charge of the extensive improvements to be made immediately and the future operation of the plant. The Washington company has always been a paying enterprise, but under the new management it is expected the earnings will be largely increased.

NEW MEXICO.

LAS VEGAS.—The contract has been let for a $150,000 power plant, to furnish this city and vicinity with power and light.

GALLUP.—The Gallup electric light plant, owned by Gregory Page, has been sold to E. C. Allen. The terms of the sale have not been made public,

but it is learned that the consideration is about $25,000. It is also said that the First National Bank is interested in the purchase. Mr. J. P. Mitchell has been appointed manager and superintendent of the plant under the new control.

NEW YORK.

BROCKPORT.—New arc lights are to be installed throughout the streets of the town.

BUFFALO.—At the recent election the citizens voted in favor of a municipal lighting plant.

MOORESVILLE.—The people have voted to issue bonds to the amount of $10,000 for the establishment of an electric light plant.

LYONS FALLS.—The village authorities have entered into a contract for a term of five years with G. H. P. Gould to furnish street lights.

WATERFORD.—The village trustees directed the light committee, president, attorney and engineer to ascertain the cost of constructing and operating an electric light plant.

MIDDLETOWN.—A majority of the stockholders of the Consumers' Light & Power Company voted to sell the company's plant to the Orange County Light & Power Company for $65,000.

NEW YORK.—The incorporation of the Hudson Electric Company is reported, with a capital of $5,000, and the following directors: E. W. Moore, F. H. Cowles and J. N. Shreve, New York.

LITTLE FALLS.—At an adjourned regular meeting of the Common Council recently held a franchise was granted to the Hudson River Electric Power Company to operate in this city for a term of 50 years.

MACEDON.—It is stated that the Town Board has granted a franchise to the Niagara & Lockport Power Company, to erect poles and wires for the transmission of heat, power and light along the highways of the town.

LOCKPORT.—Electric power from the Ontario Power Company's plant at Niagara Falls is now being received in this city. The gas and electric light company is utilizing the power, which is transmitted at 12,000 volts.

GOSHEN.—Goshen Illuminating Company has been incorporated to furnish gas and electricity. The company's capital is $25,000 and the incorporators are James Gamble and William H. Dixon, New York City, and John B. Johnston, Brooklyn.

BROOKLYN.—The Kings County Electric Light & Power Company of Brooklyn, it is reported, has applied to the State Gas & Electricity Commission at Albany for permission to increase its capital from $5,000,000 to $10,000,000 for the purpose of improving its plant.

LOCKPORT.—The Economy Light, Heat & Fuel Company, which recently obtained a 100-year franchise for light, heat, gas, power and refrigerator plants, will soon start work on its new electric light station. It is expected to have the plant in operation within six months.

POTSDAM.—A statement has been issued by the Hannawa Falls Power Company to the effect that the power company has secured the permission of all property owners along the route of the proposed power transmission line from Hannawa Falls to Ogdensburg, and that the pole line will soon be completed.

OSWEGO.—The Citizens' Lighting Company has been incorporated with a capital of $75,000 by J. C. Knight, Thomas Moore and C. A. Bentley, of Oswego. The outlook for the new lighting company is said to be more than encouraging. Contracts have been made with merchants and manufacturers embracing a period of three years and representing over $40,000.

UTICA.—The Utica Gas & Electric Company has entered into a contract with the Rome (N. Y.) Gas Company, whereby the former concern is to furnish electricity for lighting the city of Rome. A high-tension line will be built and power will be furnished from Trenton Falls to Rome, where it will be transformed to the proper voltage for the different requirements in that city.

WATKINS.—The Watkins Consolidated Gas & Electric Light Company, which went into the hands of a receiver last spring, has been reincorporated and will hereafter be known as the Watkins Illuminating & Power Company. The incorporators and chief stockholders are M. L. Driesbach, of Philadelphia, and M. H. Horn, of Jersey City. The capital stock has been fixed at $50,000.

AMSTERDAM.—Press reports state that the survey has been completed for the steel tower line between Amsterdam and Ballston, a distance of 20 miles, preliminary to the construction of work necessary to the bringing of Hudson River Electric Power Company's Spier Falls power to Utica. The survey for the balance of the line from Amsterdam to Utica will probably be started next week.

BROOKLYN.—Mr. Max Loewenthal, who of late years has devoted his attention and energies as an electrical engineer to the development of electric heating, has undertaken as a specialist the creation and development of a heating department for the Edison Electric Illuminating Company, of Brooklyn. Such an experiment is well worth the making for every local lighting company, and Mr. Loewenthal's work will be followed with deep interest.

ROCHESTER.—The stockholders of the Wayne County Electric Company, at their annual meeting, elected as directors: Charles D. Beebe, George Dunn, H. H. Crowell, Charles A. Lux, Dr. James W. Putnam, Dwight P. Chamberlain. The directors organized immediately after the stockholders' meeting, electing as officers: President, Dwight P. Chamberlain; vice-president, Charles A. Lux; secretary, Benton S. Rude; treasurer, William H. Akenhead.

LOCKPORT.—Work on the Buffalo transmission line of the Niagara, Lockport & Ontario Power Company has been begun. The line will run to Pendleton, then to Getzville, Williamsville and Buffalo. At a recent meeting of the stockholders the company elected the following board of directors: Harry H. Westinghouse, George C. Smith, Robert E. Drake, of Syracuse; Paul P. Brady, of New York; J. J. Albright, S. M. Clement, of Buffalo; Carl A. Degersdorff, of New York; William H. Gratwick, of Buffalo, and Edmund Hayes, of Buffalo. The last five take the place of I. H. Babcock, William Richmond, the Hon. Charles Hickey and William Higgs, of Lockport, and P. F. King, of Niagara Falls.

NEW YORK CITY.—New York City's first municipal electric light plant has been completed, and on October 30 was tested in the presence of a number of city officials. The current generated will be used to light the new Williamsburg bridge. By an investment of about $90,000 the city, it is expected, will make an annual saving of $12,000 in lighting the 124 arcs and 136 incandescent globes on the bridge. The plant was designed by H. de B. Parsons. There are two buildings, and the smokestack is 225 feet high. It is the first electric light works in the country to get its steam power as the result of the burning of garbage. The building which contains the furnaces and boilers is in charge of the street cleaning department, and the electric generating plant is under the bridge department.

OYSTER BAY.—After a fight that has lasted for years, the Nassau Electric Light & Power Company has absorbed the Oyster Bay Light & Power Company. Interested in the Nassau Company are Edwin D. Morgan, Clarence H. Mackay, Percy Chubb and other well-known men. The Oyster Bay company made a hard fight to keep the Nassau Company out of its territory, but at last had to succumb. The struggle between the rival companies was accompanied by many lively incidents. The Nassau people would start in to put up poles at night, but the local managers were always on the watch, and lawyers were sometimes routed out of bed at midnight to give an opinion as to the legality of the Nassau company's action. Men were sent out by the local company to chop down poles when it was thought they had been erected in violation of the law, and in some cases men employed by the Nassau company climbed to the tops of the objectionable poles and stayed there, defying their opponents to cut down the poles.

NORTH CAROLINA.

WILLIAMSON.—The town authorities want to correspond with electric companies relative to the installation of an electric light plant. S. J. Everett is secretary of the Business Men's Association.

LENOIR.—The Citizens' Light & Power Company has been incorporated with a capital of $25,000. The incorporators are H. F. Newland and W. B. Ivey. The company has been granted a 30-year exclusive franchise for an electric lighting and power plant, and will at once begin the installation of a 60-kw. single-phase lighting system, 60 cycles, 2,200 volts. The town has contracted for 21 arc lamps for five years.

ROANOKE RAPIDS.—Engineers are now preparing plans for the power house and electrical installation of the Roanoke Rapids Power Company. It is proposed to construct a dam across Roanoke River at this point, which for the first development will give the company about 9,500 horse-power. Later it is proposed to raise the dam so as to give about 25,000 horse-power for 11½ hours per day. C. P. E. Burgwyn, Richmond, Va., is the engineer in charge. H. C. Cooper, general manager, writes that the contract for the new power plant will probably not be let before spring.

SALISBURY.—The development of a large hydro-electric plant is being undertaken in Davidson County, five miles from Salisbury. D. Hartley, of Yadkin College, J. H. Swicegood, of Tyro Shops, and Prof. J. M. Bandy, of Greensboro, are among those who head the movement and have incorporated the Yadkin Development Company. The plan is to dig a canal 11 miles in length from a point on the Yadkin River at Yadkin College to a suitable location near Linwood, through which the current of the Yadkin River will be turned. The canal is to be 80 feet wide at the base and will average about 15 feet in depth. It is estimated by the engineers that not less than 30,000 to 35,000 horse-power will be available at one point when the canal shall have been completed.

NORTH DAKOTA.

LEEDS.—The Leeds Electric Light & Power Company will install a new electric light plant. A site for the plant has been secured and the construction work will be started immediately.

GRAND FORKS.—Edward A. Healy, of Red Lake Falls, has a plan to supply electric light for the city and was here recently talking over the venture to some local business men. His plan is to utilize the power of Thief River Falls to generate a current which if extended here will furnish cheap light.

OHIO.

ARLINGTON.—The electric light plant at Arlington burned recently. There was no insurance.

COLUMBUS.—The Lima Electric Railway & Light Company has increased its capital stock from $850,000 to $1,250,000.

FOREST.—At a special meeting of the Forest town council it was decided to advertise for bids for the erection of an electric lighting plant.

BELLEFONTAINE.—Appropriations have been made by the Bellefontaine council for a new municipal electric light plant to cost $50,000.

TOLEDO.—J. T. Ross became chief engineer of the Toledo Railways & Light Company on November 1. He is a well-known traction expert and engineer.

ASHTABULA.—The superintendent of the electric light plant has petitioned the finance committee for an appropriation of $7250 for improvements to the electric light plant.

PAINESVILLE.—The stockholders of the Commercial Electric Company held their annual meeting recently. The officers elected were T. E. Durban, president; W. N. Collister, vice-president, and W. E. Malin, secretary and treasurer.

CAREY.—Improvements have recently been made at the water works and lighting plant here, of which Harry C. Fink is manager and engineer. Two new Skinner engines have been installed, one of 150 horse-power and the other of 60 horse-power capacity; also a 100-kw. single-phase Wood generator.

JAMESTOWN.—Although the Jamestown Electric Light Company has been lighting the streets of Jamestown for ten years, it has just been granted a franchise. More lights will be used and a new contract made. It is said the town could have avoided paying light bills any time because of the lack of a franchise.

MANSFIELD.—The stockholders of the Mansfield Electric Light & Power Company have chosen directors. The following officers were elected by the board of directors: President, C. W. Upson; vice-president and treasurer, J. J. McIntyre; secretary and superintendent, W. C. Hedges.

CLEVELAND.—The people of Cleveland have voted in favor of giving the Bradley Electric Light & Power Company a franchise to furnish light, heat and power in Cleveland, in competition with the Cleveland Electric Illuminating Company. Whether the council will complete the grant to Mr. Bradley or not depends upon the attitude of the Legislature toward a home-rule law for Cleveland.

TOLEDO.—The Toledo Gas, Electric & Heating Company has about completed its lines in the downtown section of the city. The new turbine engine is in operation and is supplying current for the West End, while two additional 1,500-h.p. steam turbines have been ordered adapted for driving a direct-connected 60-cycle generator running at 1800 revolutions per minute and giving 7200 alternations per minute. They will be provided with secondary governor valves by means of which 50 per cent overload may be developed, or full load developed when operating with condenser. The generators will have four poles and will deliver three-phase current at 4400 to 4800 volts. The turbines will be of the Westinghouse make.

EAST LIVERPOOL.—Articles have been filed with the Secretary of State increasing the capital stock of the East Liverpool Traction & Light Company from $6000 to $3,000,000, as the result of a traction and light merger in southeastern Ohio. The deal includes the suspension bridge over the Ohio between East Liverpool and Chester, Pa., the East Liverpool & Rock Spring traction line, Rock Spring Park; the Chester Light & Power Company and the People's Light & Power Company. These properties will be merged with the electric lighting companies of East Liverpool and Wellsville. It is said that this move is a preliminary to a merger of all the electric lighting companies in eastern Ohio. Options have been taken on the Steubenville electric lines which extend to Toronto, and to Brilliant, and a gap is to be filled in between Toronto and Empire. Buffalo (N. Y.) capital is behind the movement.

OKLAHOMA TERRITORY.

LEHIGH.—The Consumers' Ice Company will install electric lights at Lehigh.

WOODWARD.—The Woodward Cotton Company has been granted a franchise to furnish the city with electric lights.

SHAWNEE.—Charles A. Freuauff, of New York, has bought the Shawnee Light & Power Company's plant and entire system, in Shawnee, for $108,000.

OREGON.

ASTORIA.—W. W. Whipple has secured a franchise to construct an electric light and gas plant and telephone system in Astoria.

SALEM.—The Calbe Cove Power Company, of Sumpter, has filed articles of incorporation, with $100,000 capital. O. C. Wright, T. C. Gray and E. Ray Jones are the incorporators.

ELGIN.—The Grand Ronde Power Company (Fred. Housch, engineer, La Grande, Ore.), is to extend its line to Elgin, and furnish light and power; probable cost of work, $20,000.

JUNCTION CITY.—The Gilmore Water Power Company has been incorporated here by S. P. Gilmore, Emma Gilmore and Eliza Gilmore for the purpose of establishing water works for irrigation and other purposes.

HAINES.—At a regular meeting of the Common Council held recently the application of J. F. O'Bryant to install and operate a power and light plant in the corporation limits for a period of thirty years was passed to its third reading and granted.

EUGENE.—W. T. Campbell and associates will, under the name of the Oregon Electric Power Company, appropriate water from Mackenzie River for the purpose of generating electric power. The power house will be located about eleven miles from Eugene. The company offers to furnish power for the proposed municipal electric light system.

EUGENE.—The City Council has employed Engineer Kelsey, of Salt Lake, Utah, to make surveys, plans and estimates for the proposed municipal electric light plant and water works, for which the citizens have voted to issue $200,000 bonds. The site for the power plant is reported to have been selected on McKenzie River, about thirty miles east of Eugene.

OREGON CITY.—H. W. Hageman, of Stone City, Ore., has completed financial arrangements for the construction of an electric light and power plant on Clackamas River, about seven miles above Oregon City. He will build a 35-ft. dam and construct a large power plant. It is proposed to furnish light and power to Park Place, Gladstone, Clackamas Heights, Oregon City and Portland.

BAKER CITY.—The Northwestern Gas & Electric Company, which practically controls all the gas and electric light plants from Boise to Walla Walla, will have an opposition fight in Baker City, as the Powder Valley Light & Power Company has petitioned the City Council for a franchise. The Powder Valley Company offers to pay the city three per cent of its gross earnings for the franchise, and, in addition, proposes a maximum scale of prices, which is very far below that now charged by the Baker City Gas & Electric Company, which is owned and controlled by I. P. Anderson, of the Northwestern Gas & Electric Company. The Powder Valley Company is erecting an immense plant on Powder River, and will string wires as far west as La Grande.

PORTLAND.—Machinery costing $165,000 for the Oregon Water Power & Railway Company is being delivered. The company is constructing a dam in the Clackamas River, at Cazadero, thirty-seven miles from Portland, and will install a plant to develop 20,000 horse-power. President W. H. Hurlburt officially announces that the plant will be completed and in operation before the end of next summer. The total cost will be $225,000. The Bullock Company, of Cincinnati, has the order for generators. The Stanley Company, of Pittsfield, Mass., is manufacturing the transformers. The water wheels come from the Pratt Iron Works, Dayton, Ohio. The power to be generated will be used in operating 100 miles of electric railway between Portland and Cazadero and branch lines in and about this city; also the electrically lighted pleasure park, "The Oaks." There will be a large surplus of power, and this will be delivered under a contract to the Portland General Electric, to be used in commercial lighting and power in this city.

PENNSYLVANIA.

LEBANON.—Geo. R. Hersey and Eli Nisley have secured an electric light franchise.

MALVERN.—Malvern Electric Light Company has been incorporated with a capital of $5000.

WEST CHESTER.—The Ridley Creek Supply Company has extended its line through Williston.

LEBANON.—The Edison Electric Illuminating Company will supply Myerstown and Avon with electric lights.

PLAINS.—Plains residents are considering the the formation of a company to furnish electric lights for this town and Miner's Mills.

FALCONER.—E. W. Jordan, of the Corry Electric Lighting Company, has secured a five-year contract to light the streets of Falconer.

YORK.—It is reported that the Conewingo Electric Power Company is about to construct a plant to furnish light to York, capable of supplying 30,000 horse-power.

HOMESTEAD.—Homestead business men have organized a light, heat and power company, which is to be capitalized at $100,000 and chartered to operate throughout Allegheny County.

MANHEIM.—Manheim borough has given a five-year contract for lighting the borough to the Manheim Electric Light & Heat Company at $11.50 per light per year. This is $2.50 per light less than the old contract, and will save the borough about $200 a year.

BENTON.—Definite steps have at last been taken towards bringing the Benton electric light plant into reality. The company has engaged W. O. De Witt of this town as consulting engineer, and he will at once prepare plans and specifications for the erection of the power house.

PHILADELPHIA.—S. L. Brumbaugh, general manager of the Juniata Hydro-Electric Company, writes in regard to the construction of the proposed electric plant on Juniata River, that the total cost of the work will be about $1,000,000. Bids for excavation steam shovel work, etc., will be received in about 30 days. Bids for electrical equipment will be received about January 1. Engineer, Wm. H. Cushman.

SOUTH CAROLINA.

EDGEFIELD.—It is proposed to install an electric light plant here.

BISHOPVILLE.—The corporators of the Bishopville Light & Power Company have secured a charter from the State of South Carolina.

BAMBERG.—It was voted on October 24 to issue $15,000 bonds for the construction of an electric light plant. The Board of Public Works will have charge of the construction.

SOUTH DAKOTA.

WILMOT.—A new electric light system is being installed at this place.

ABERDEEN.—F. W. Raymond, City Auditor, writes that the citizens voted November 9 to construct a municipal electric light plant.

SPEARFISH.—The Black Hills Traction Company is building a canal 5½ miles long, which will have a fall of 103 feet, and furnish from 1000 to 1200 horse-power. The dam to receive this water is almost completed. An electric light and power plant will be built to furnish power for mining companies and also for the trolley line which the Black Hills Traction Company intends to build from Spearfish to Deadwood and afterward to extend to various other points in the Black Hills.

TENNESSEE.

DAYTON.—C. F. Dowker, of Grandview, has purchased of Thomas E. Stone the city electric light plant and assumed charge immediately.

LAWRENCEBURG.—The citizens have voted to issue $25,000 bonds for the construction of water works and an electric light plant. Jas. Dunn, city secretary-treasurer, writes that no engineer has been employed as yet.

CHATTANOOGA.—A twenty-year exclusive franchise is for sale for a water and an electric light and power system, including rights of way, etc. For further information address I. L. Faucett, Chamberlain Building, Chattanooga.

MEMPHIS.—The Boardman Electric Company has filed an application for an amendment to its charter in order to change the name of the company to the Bluff City Electric Company. The incorporators are: H. H. Carson, R. M. Ellet, G. B. Thornton, Jr., and H. E. Hart.

KNOXVILLE.—The City Council, it is reported, has authorized the Board of Public Works to award to the Knoxville Railway & Light Company a contract for 303 or more arc lights at an annual cost of $72.50 per light per year, for a period of ten years, and to the Carbon Light & Power Company, a contract for 150 or more Welsbach gas lights of 62 candle-power each, at an annual cost of $21.50 each.

CHATTANOOGA.—We are informed that W. J. Oliver & Company, of Knoxville, Tenn., have secured the contract for the concrete work of the lock and dam power plant to be constructed at Hales Bar in Tennessee River by the Chattanooga-Tennessee River Power Company; contract price about $1,000,000. Additional contracts will be let in the near future for other work in connection with the above plant to include hydraulic and electric installation, structural work of power houses, transformers and transmission line. John Bogart, consulting engineer, 16 Exchange Place, New York, N. Y.; C. E. James, president, Chattanooga.

CHATTANOOGA.—Following the letting of the contract for the concrete work of the lake and dam for the power plant to be erected at Hale's Bar, in the Tennessee River, the Chattanooga & Tennessee River Power Company has

applied for an increase in the capital stock from $3,000,000 to $3,500,000. This is for the purpose of increasing the capacity of the power plant. According to the original plans the company was to erect a plant which would have a capacity of 36,000 horse-power. It is understood that this will now be increased to 50,000 horse-power.

TEXAS.

BEAUMONT.—R. C. Duff and others have applied for an electric light franchise here.

KILLEEN.—A local company has been organized for the purpose of installing an electric light plant at Killeen.

CLIFTON.—L. B. Thornton has sold his electric light plant and flouring mill to the Thornton Milling Company.

MARFA.—J. B. Covington, of Hearne, Texas, is going to put in both an electric light plant and telephone exchange in this place.

EAGLE PASS.—The Texas-Mexican Electric Light & Power Company has increased its capital stock from $40,000 to $80,000.

VAN BUREN.—A deed has been filed here transferring the Van Buren electric light and power plant to the Fort Smith-Van Buren Bridge & Traction Company.

MIDLOTHIAN.—The Midlothian Ice, Light & Water Company has been incorporated, with a capital of $20,000, by C. A. Moore, W. W. Meyer and others, all of Midlothian.

DUBLIN.—The Dublin Gas & Electric Company has been incorporated with a capital stock of $50,000 by J. F. Strickland, Oscar Godwin, of Dallas; M. B. Templeton, of Waxahachie; R. B. Sticher, of Sherman, and J. R. St. Clair, of Dublin.

WHITESBORO.—The council has granted a franchise to M. P. Kelly, of Gainesville, Texas, for the installation of a water works system. As soon as the installation is completed, Mr. Kelly will begin the construction of an electric light plant and sewerage system.

UTAH.

COALVILLE.—The City Council has awarded a contract to Thomas L. Allen for an electric power plant in this city.

SALT LAKE CITY.—Francis M. Lyman, Jr., has filed an application with the County Commissioners for a franchise to erect poles and string wires along the county highways. He owns water rights on Mill Creek and proposes constructing a power plant.

SALT LAKE CITY.—Malad Light & Power Company has been organized to succeed to the franchise, plant and rights of G. C. McLaughlin and Frank Moore in the town of Malad, Idaho. $100,000. C. F. Little, president; D. S. Taggart, vice-president; G. H. Jay, treasurer; J. A. Largent, secretary.

RICHFIELD.—A. J. Poulson has had his application for a large amount of water in the Sevier River for power purposes approved. He will form a company for the purpose of putting in a plant to utilize the power. It is purposed to build a plant to cost $60,000, three miles south of Elsinore, to develop electrical energy for Gold Mountain and for Richfield as well. The water power granted will develop 1000 horse-power.

RICHFIELD.—James Christensen, of Salt Lake, and H. N. Hayes, of Richfield, have become associated with Thomas and D. R. Brown, the original owners of the Richfield electric plant. The company has secured the upper water power rights above Glenwood. The company is incorporated under the title of the Richfield Light & Power Company and intends extending a line to Glenwood for the purpose of furnishing that town with light.

HEBER.—In addition to establishing an irrigation system to supply the settlers of Blue Bench on the Uintah reservation, the Blue Bench Co-operative Water Company (Irwin E. Pratt, secretary) also proposes furnishing electric light and power, and has filed application with the State Engineer at Salt Lake City for 200 second-feet of water from Rock Creek in Wasatch County, which it proposes developing and transmitting to Heber and elsewhere. The diverting canal will be 36,500 feet long.

VIRGINIA.

NORFOLK.—J. Edward Cole and W. D. Pender, representing separate interests, have each offered to install an independnt electric lighting and power plant in Norfolk if the retail merchants will subscribe to a certain amount of stock.

LYNCHBURG.—The new power house of the Lynchburg Traction & Light Company, on the James River, three miles above the city, has been put into service. The plant is to supply current for the street cars and for commercial lighting and power for factories. At present it has a capacity of 4500 horse-power, which can be largely increased. The plant is declared by experts to be one of the best in the South. It has been under construction for eighteen months and has cost upward of $150,000.

WASHINGTON.

BELLINGHAM.—The Bellingham City Council has ordered thirty-nine new arc lights for street lighting purposes.

OAKESDALE. — Mr. Shields, of Moscow, Idaho, is interested in the construction of an electric light plant at this place.

TENINO.—S. W. Fenton, it is reported, has applied to the County Commissioners at Olympia, for an electric light and water franchise for Tenino.

KENNEWICK.—C. F. Cochran and C. E. Wood, of Genesee, Idaho, have applied for a franchise for an electric light plant and water works here.

TACOMA.—The Sunnyside Council has entered into a lighting contract with the Prosser Falls Land & Power Company. The line will be built via Mabton.

WENATCHEE.—The Council, it is reported, is considering the question of purchasing the electric light plant of the Wenatchee Electric Power Company for $80,000.

GEORGETOWN.—The Seattle Electric Company has purchased within the last four months 18 acres of ground in Georgetown, on which it will build rolling stock, car barns and repair shops.

PALOUSE.—The Washington Water Power Company has begun work on its plant here, which will furnish power and light to Rockford, Fairfield, Latah, Tekoa, Farmington, Garfield, Colfax and Oakesdale.

BALLARD.—The entire plant and franchise of the Ballard Electric Company has been sold to the Seattle Electric Company, and it is stated that many improvements and additions will be made to the plant.

PORT ANGELES.—Mr. W. S. Hoskins, of Seattle, has made a proposition to take over the present electric light plant here, upon a twenty-year lease, for the purpose of superseding the city in the lighting business.

GARFIELD.—The city council of Garfield has granted a franchise to the Moscow (Idaho) Light & Power Company to light the city with electricity. Work on the line will begin January 1, 1906, and is to be completed July 1.

WEST SEATTLE.—A recent election resulted in the decision to issue $9000 bonds for the purpose of adding a lighting plant to the present municipal street railway plant. Specifications can be obtained from City Clerk W. G. Dickinson after January 1, 1906.

EVERETT.—The City Council has favored a motion made by Mr. Myers that the clerk be instructed to advertise for bids on the city lighting contract previous to the expiration of the present contract with the Everett Electric Company next March. The resolution provided that bids be submitted on contracts for five, seven and ten years.

DAYTON.—The Dayton Electric Company has been incorporated, capitalized at $75,000. Improvements are now in progress, aggregating $20,000. The old steam and water power plant will be replaced by a complete new hydraulic plant. The new barrel flume, 1500 feet long and fifty-five inches in diameter, will double the power of the old open flume and will enable steam power to be dispensed with. The new plant will run night and day, and during the day will furnish power for driving machinery in Dayton.

SNOQUALMIE FALLS.—The management of the Platt Iron Works Pacific Coast district agency has received reports of very successful tests of the new water wheel now in operation at the Seattle-Tacoma Power Company's plant at Snoqualmie Falls, Wash. The Type B. Victor turbine wheel direct-connected to a Westinghouse 5000-kw., three-phase generator tested at full gate developed 8000 kilowatts at the switchboard. This makes the capacity of the wheel 11,200 horse-power when operated at 300 r.p.m. under a head of 270 feet of water. This increase of capacity will be of much benefit to the company's service in the Puget Sound cities.

WALLA WALLA.—Secretary S. D. Sinkler, of the Northwestern Gas & Electric Company, has issued notices that there will be a meeting of stockholders at Walla Walla, December 21, for the purpose of voting on the proposition of increasing the capital stock of the company from $650,000 to $1,000,000 by the issuance of $350,000 8 per cent cumulative preferred stock, entitled to priority, both as to dividends and in the distribution of the assets upon dissolution of the company. The object of the increase in the capital stock is believed to be the building of another power plant on the upper Walla Walla River to provide for the rapidly increasing demands for power in Walla Walla, Pendleton, Athena and Weston.

WEST VIRGINIA.

PARKERSBURG.—The Acme Electric Company has secured its charter of incorporation, and at a recent meeting it was formally organized. The officers elected are: President and general manager, Henry M. Moses; vice-presidnt, Frank S. Mead; secretary, Richard K. Gibson; treasurer, Lewis P. Self; superintendent, Hugh J. Henry.

WISCONSIN.

MENASHA.—Menasha has voted to install an electric light plant.

RHINELANDER. — The Rhinelander Light Company has sold its wiring and supply branch of the business to C. A. Sutliff, of Grand Rapids, Mich. He will put in a full line of electrical goods.

MUKWONGO.—The Milwaukee Electric Railway & Light Company has come into possession of the mill property of John Hewitt. It is understood that the mill property will be used as a power house site.

FOND DU LAC.—T. F. Grover, who resigned recently as general manager of the Eastern Wisconsin Railway & Light Company, with headquarters in Fond du Lac, has moved to Chicago with his family and is now engaged in business in that city.

MILWAUKEE.—The Municipal Electric Light & Power Company, of this city, has been incorporated to supply electric light and power to the city of Milwaukee and its residents; capital, $100,000. Incorporators: L. S. Biron, J. A. Wallis and A. C. Moeller.

MILWAUKEE.—John I. Beggs, president and manager of the street railway company, says that unless the city enters into a contract for street lighting by the expiration of the present contract, December 15, the street lights will be turned off and the entire city will be in darkness.

LA CROSSE.—A combination of the electric lighting plants and electric railways in the vicinity of La Crosse is said to be in contemplation. The properties involved are announced as the La Crosse Railway Company, the Wisconsin Light & Power Company, the La Crosse Gas & Electric Company, and the proposed La Crosse & Black River Railway. It is purposed to transmit power from a large power plant on the Black River, near Black River Falls.

WYOMING.

LARAMIE.—The electric light difficulty in Laramie has been finally adjusted by the purchase of the old plant by the new company, known as the Laramie Light & Power Company, with a capital of $75,000, and represented by W. C. Sterne, of Littleton, Colo. The agreement to purchase the plant was reached at a meeting held at Littleton. The purchase price is to be the sum of $40,000 as a first mortgage on the plant. The new company contemplates extensive improvements, including the installation of an alternating current system.

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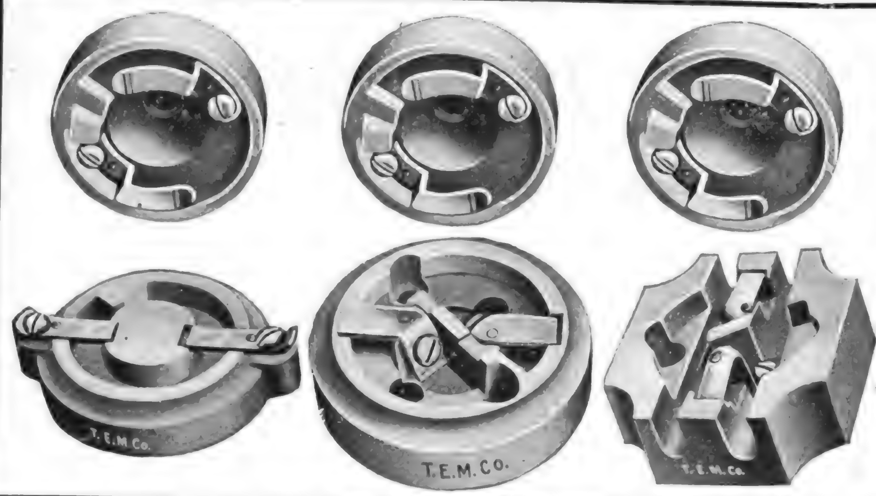

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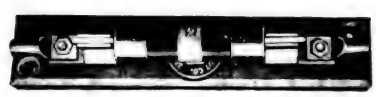

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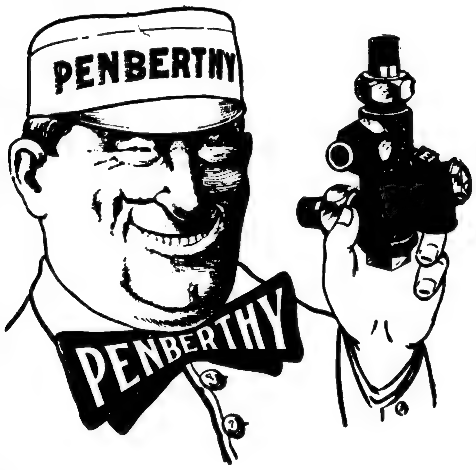

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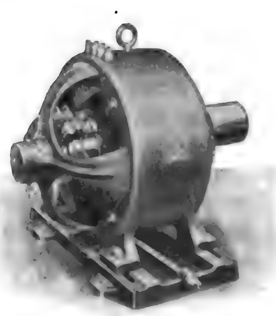

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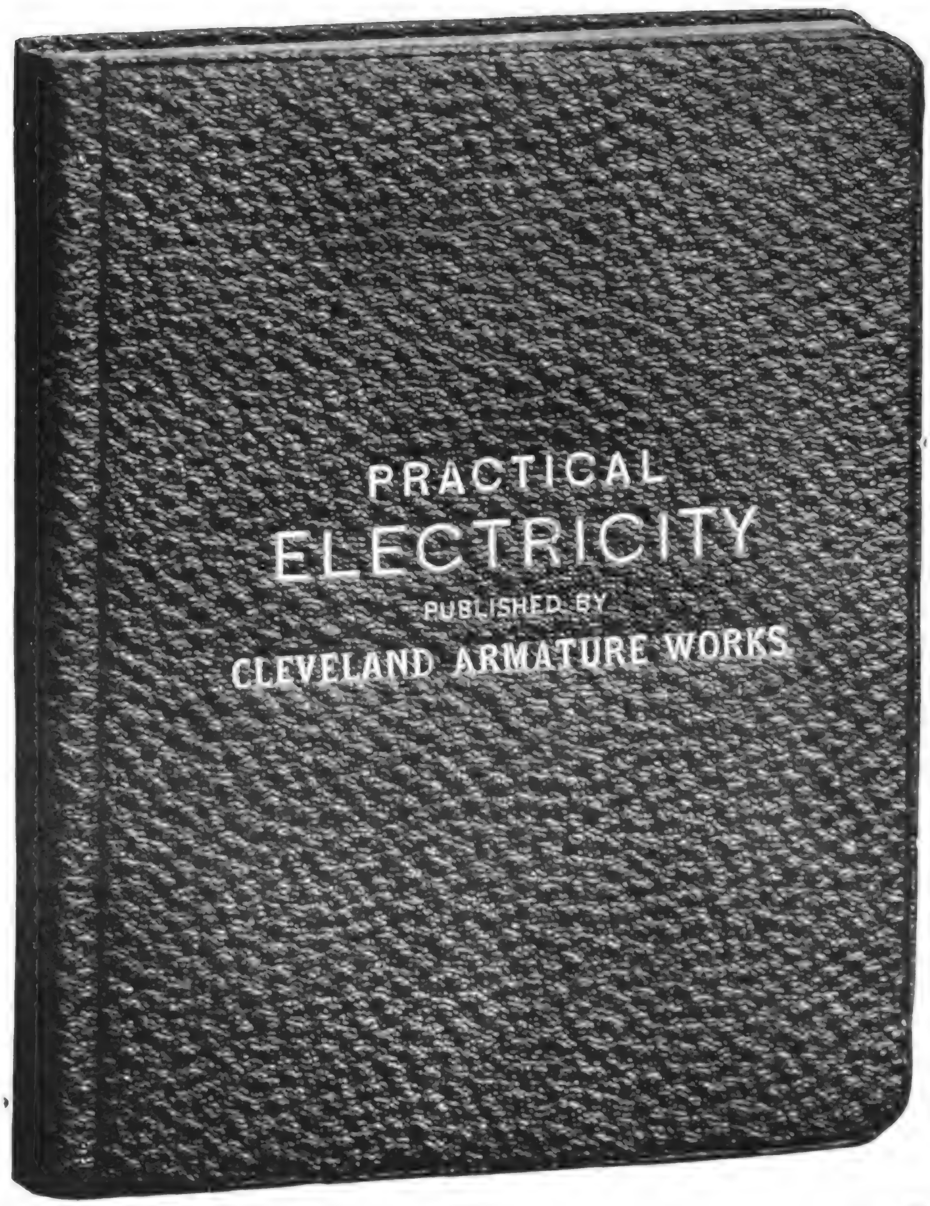

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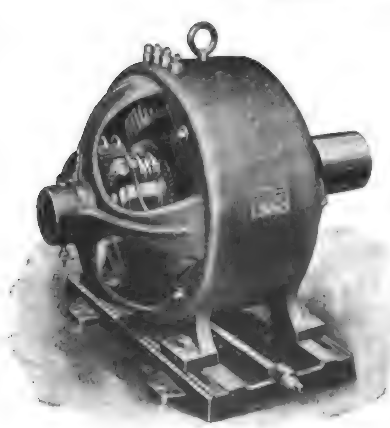

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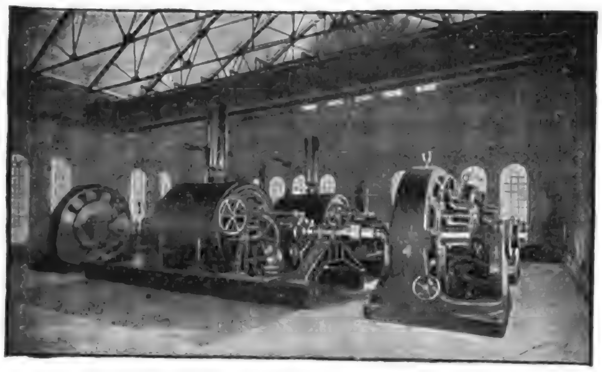

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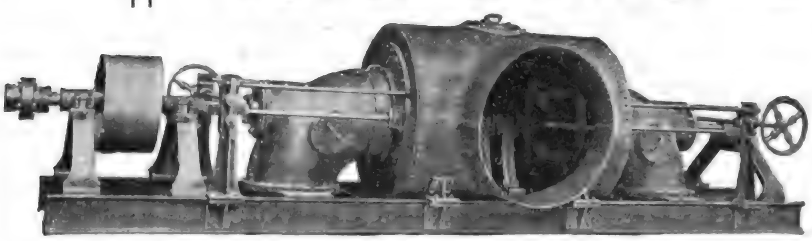

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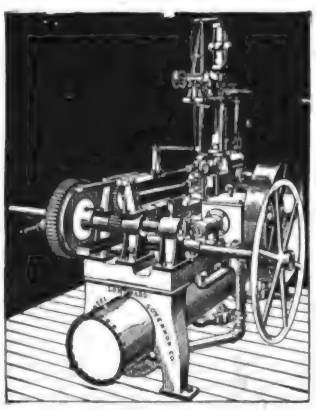

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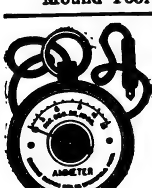

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0 to 15, 0 to 20 Amperes

"READY TO USE," with flexible cord attached and contact spur in case, which, by turning thumb nut, is drawn back into case, when carried in pocket. Can be used in any position, and works in either direction of current. **Is provided with a neat kid-leather case.**

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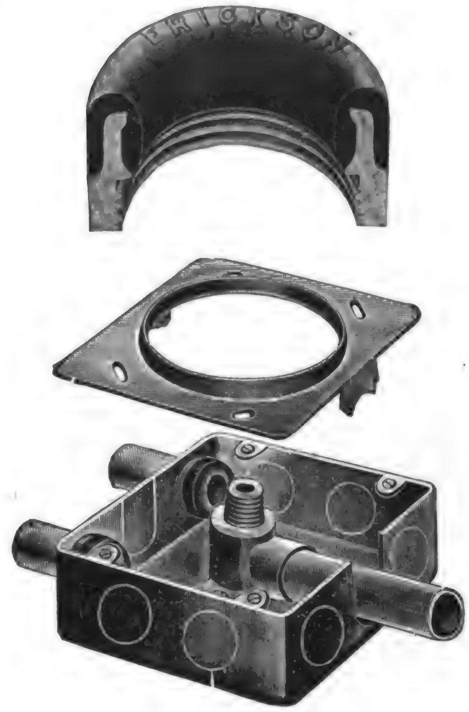

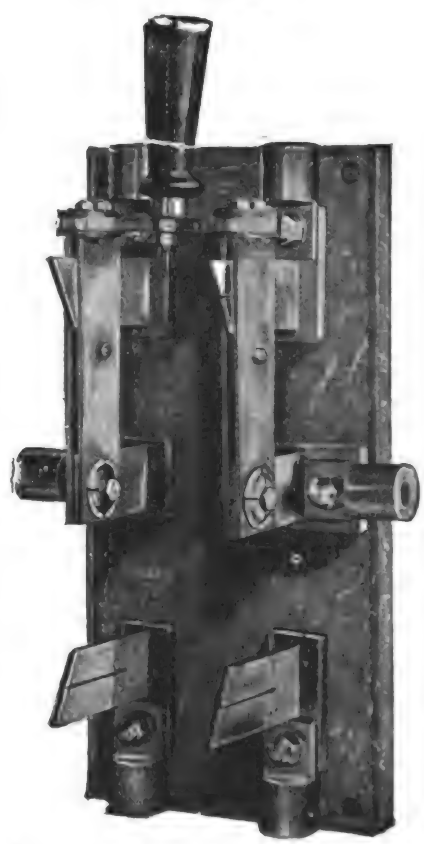

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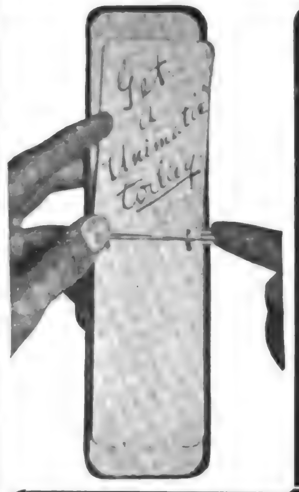

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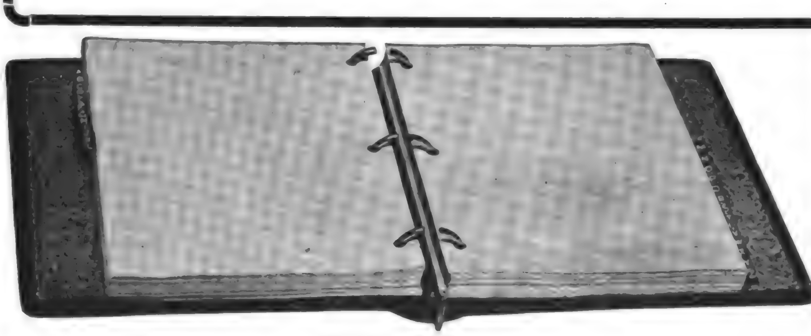

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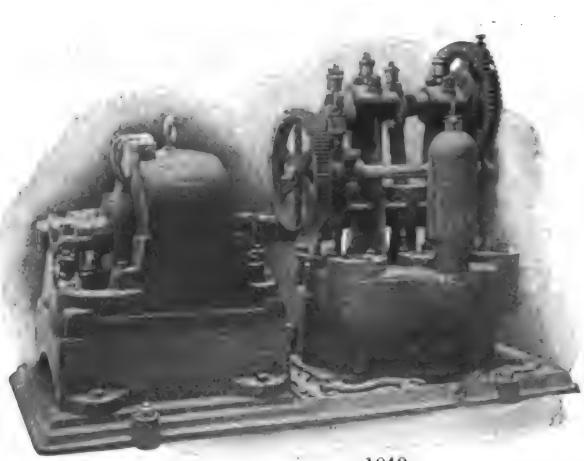

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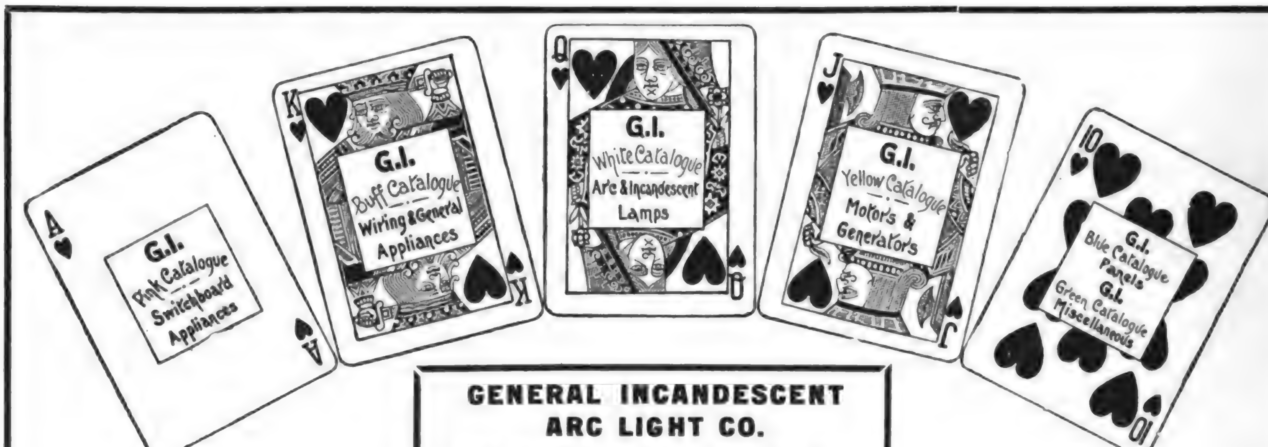

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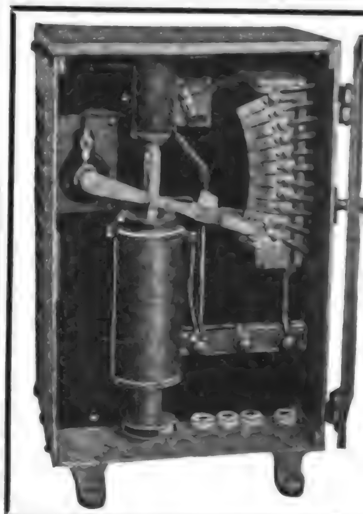

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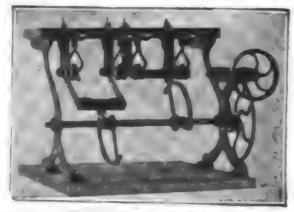

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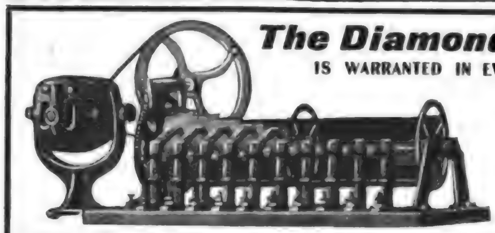

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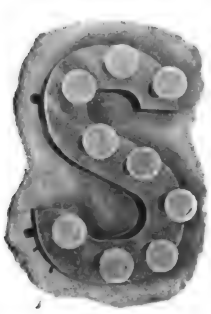

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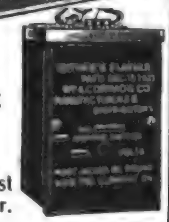

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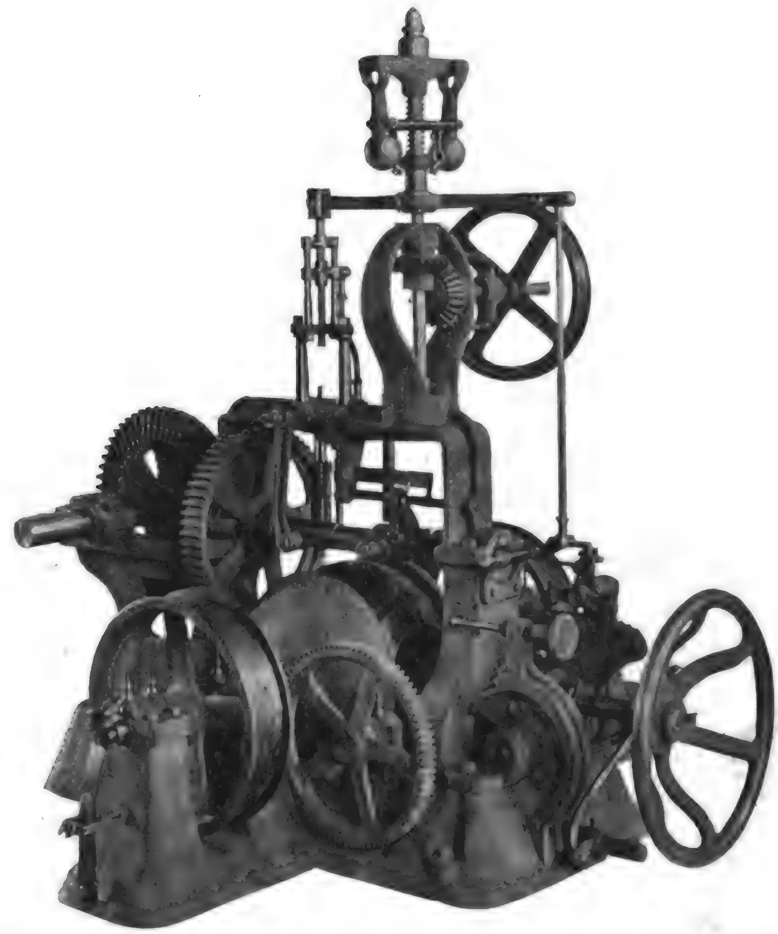

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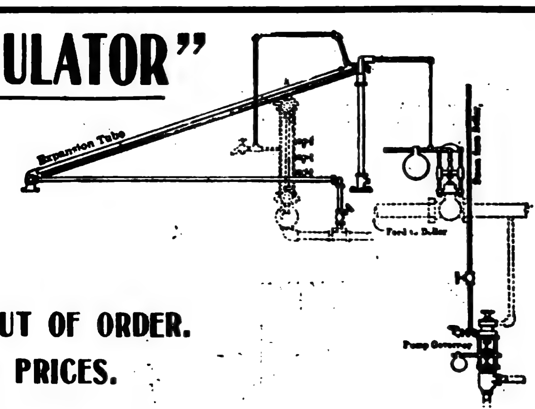

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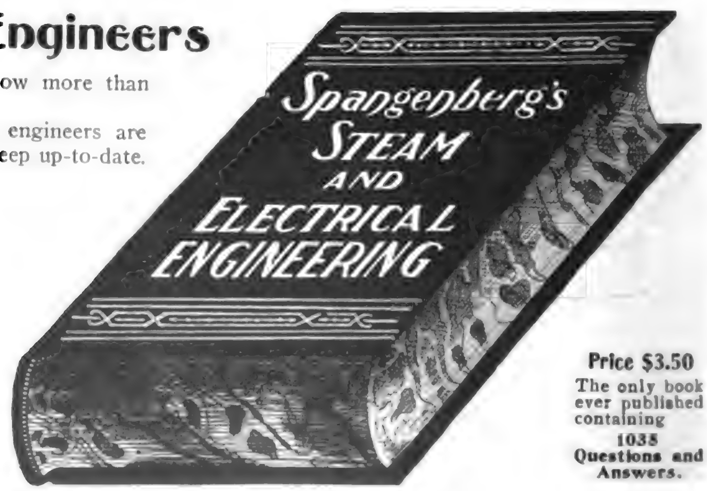

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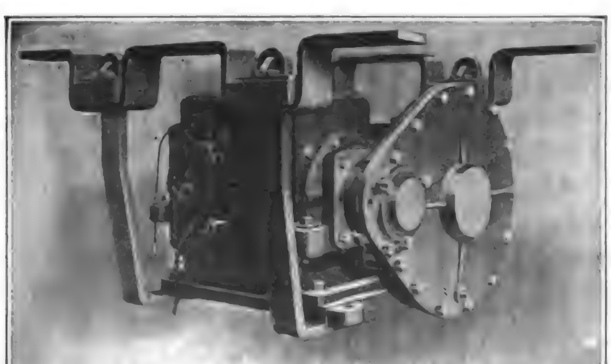

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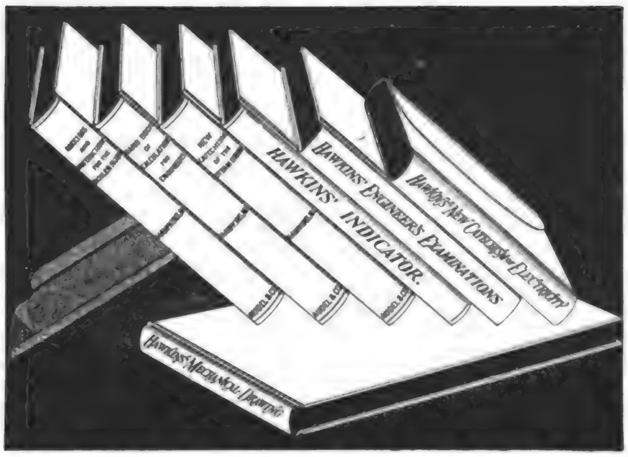

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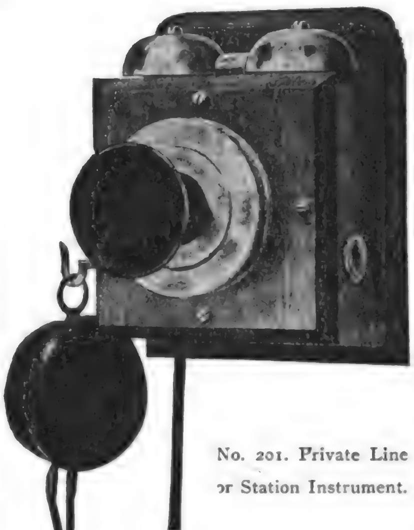

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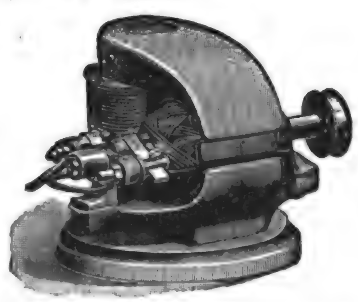

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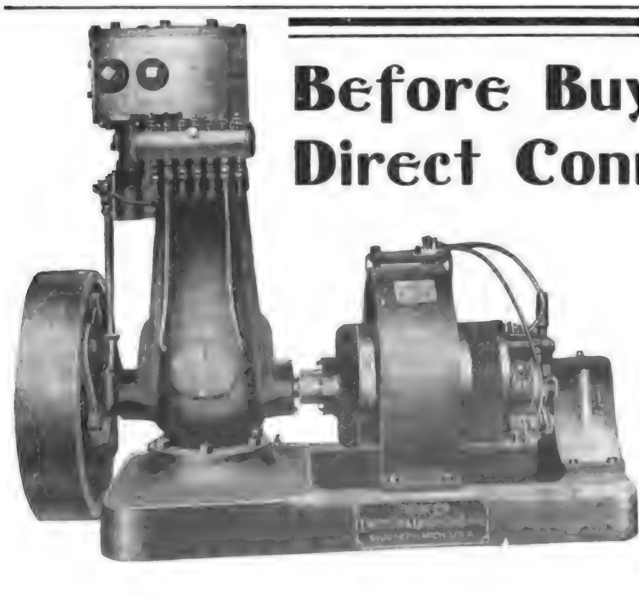

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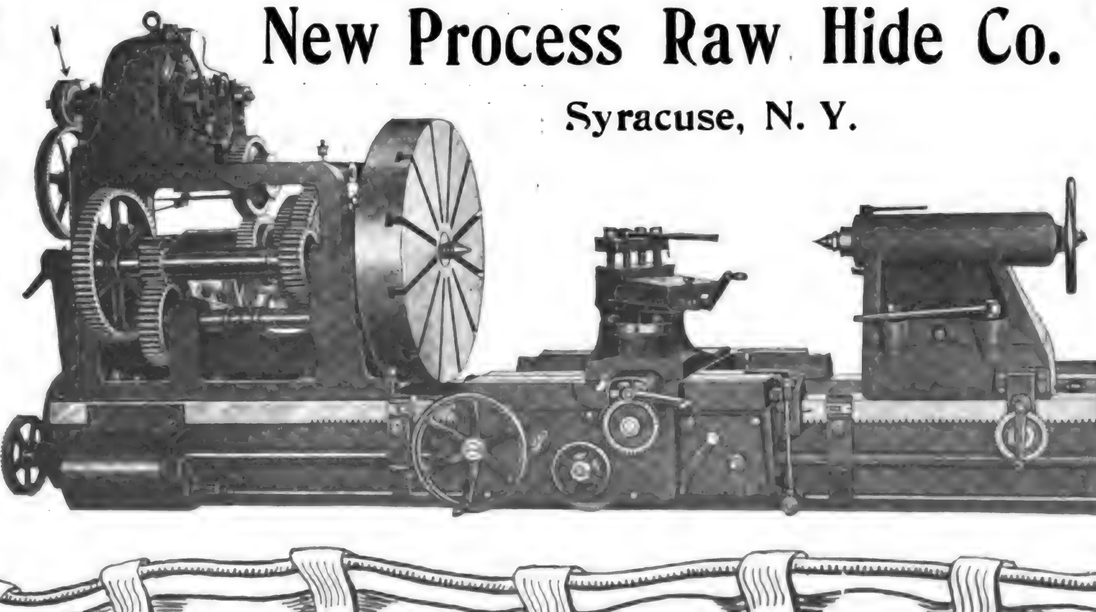

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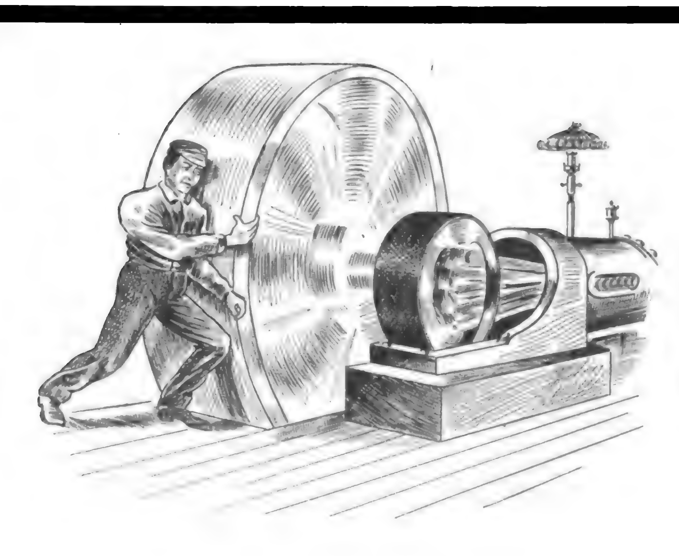

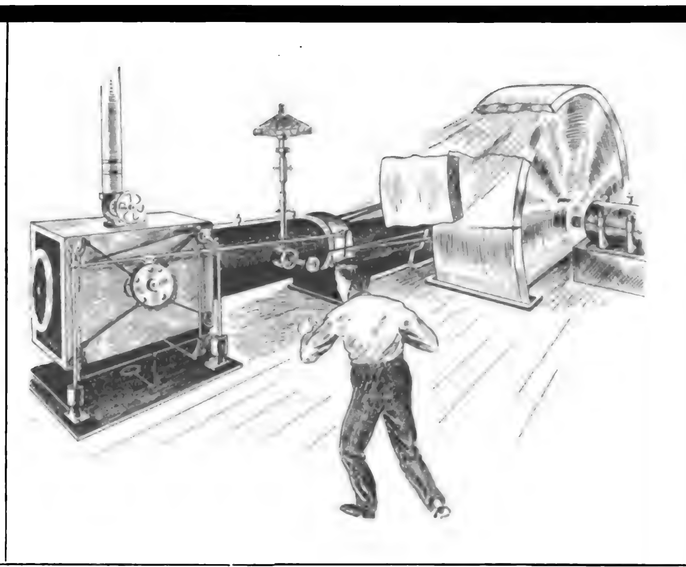

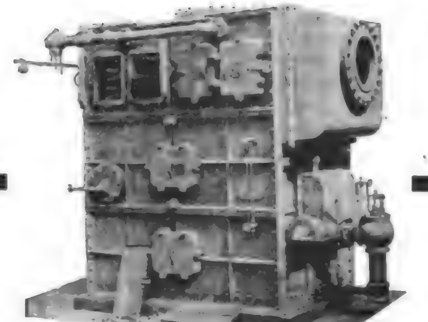

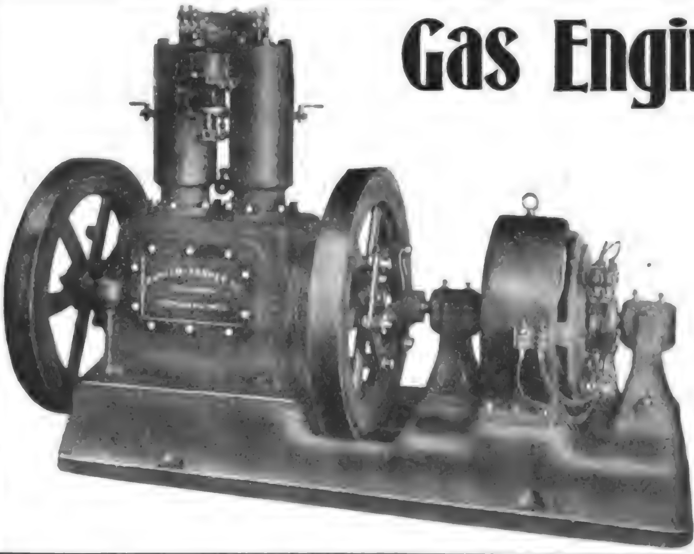

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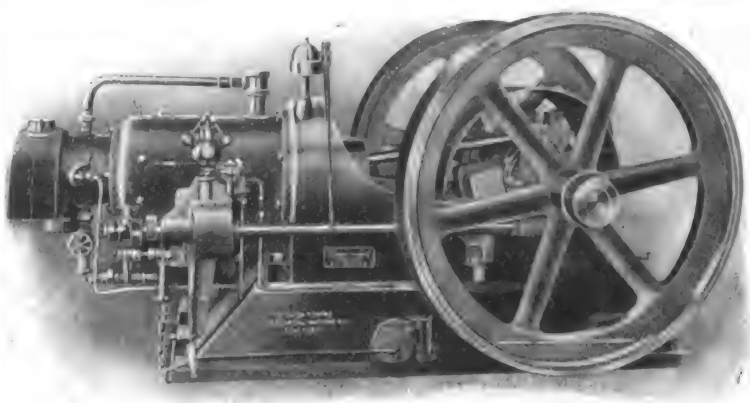

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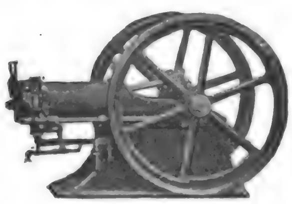

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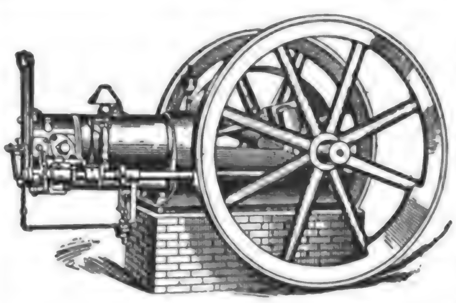

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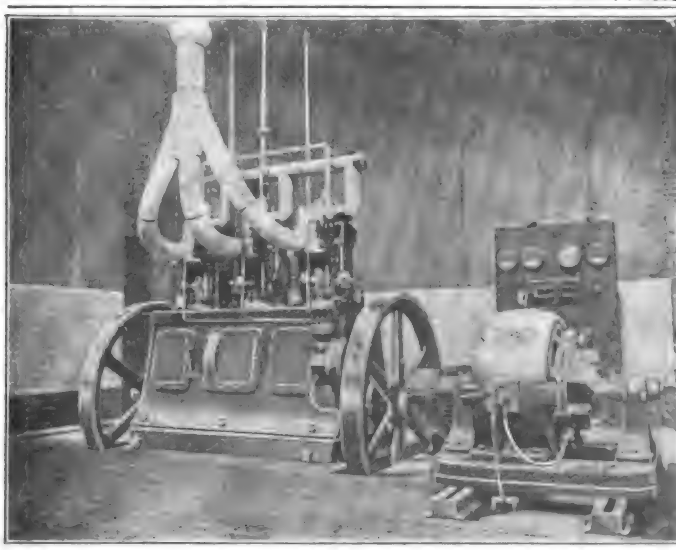

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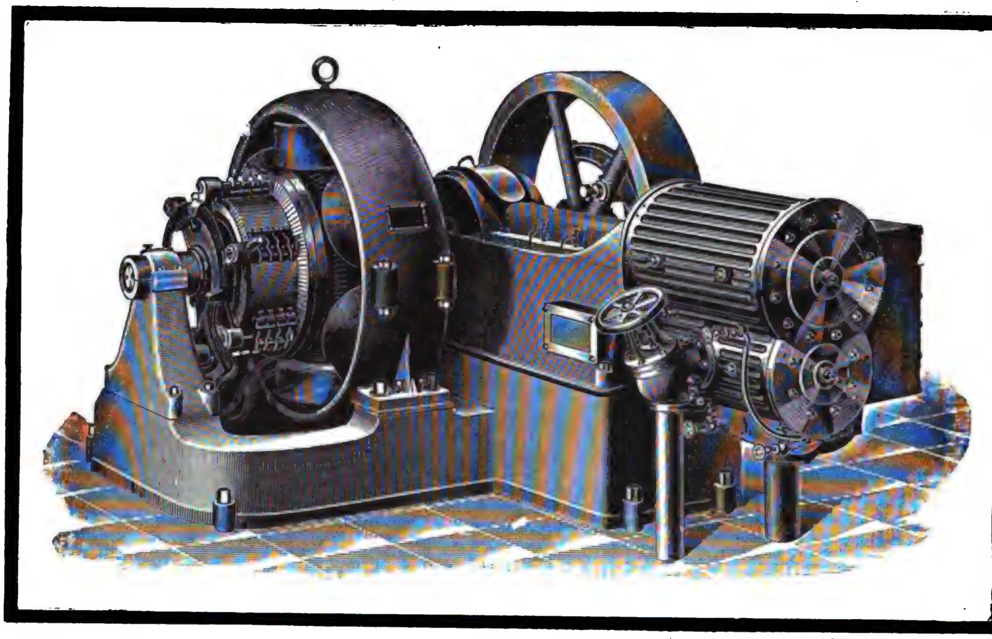

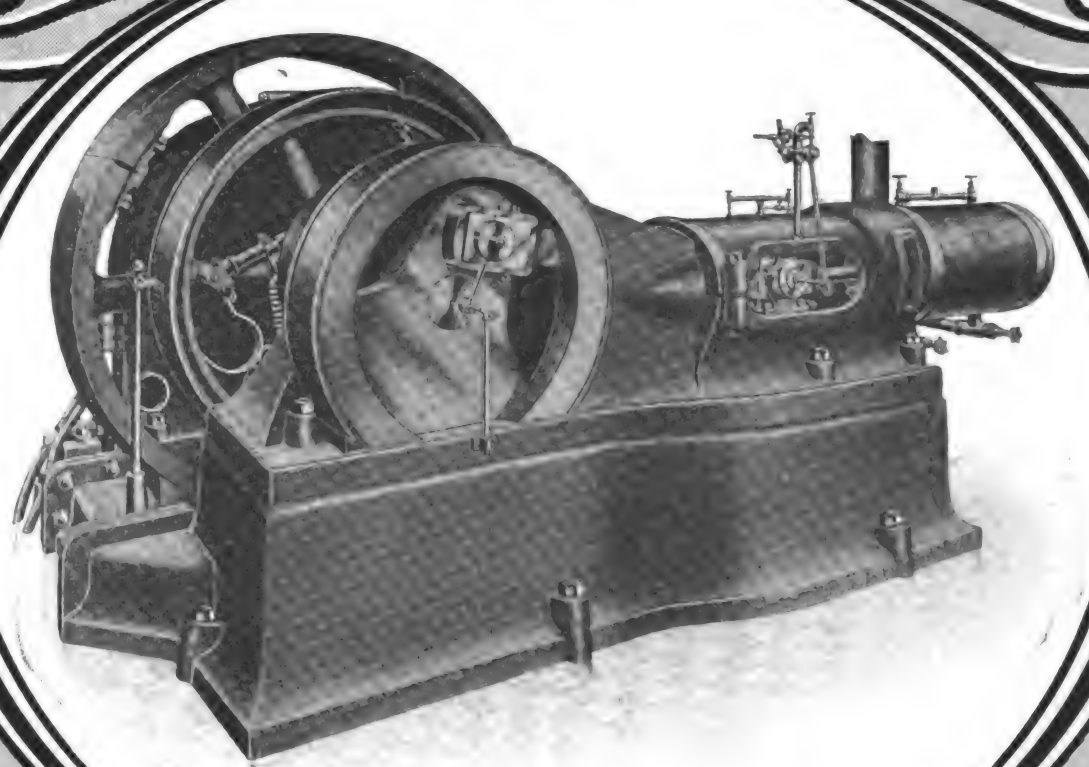

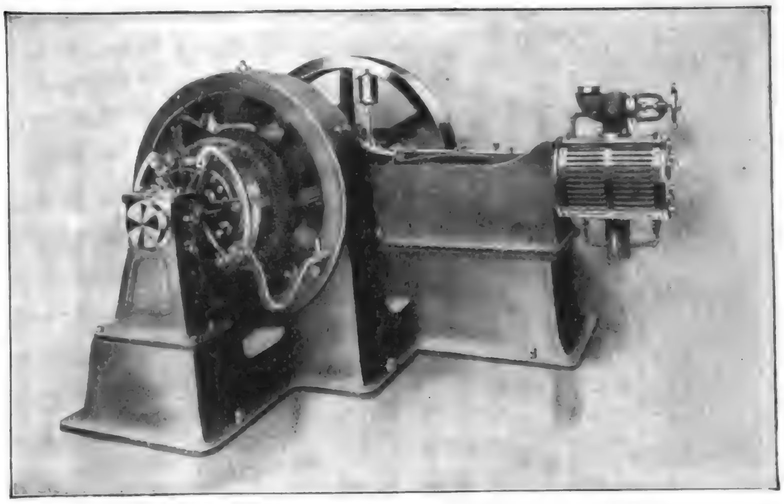

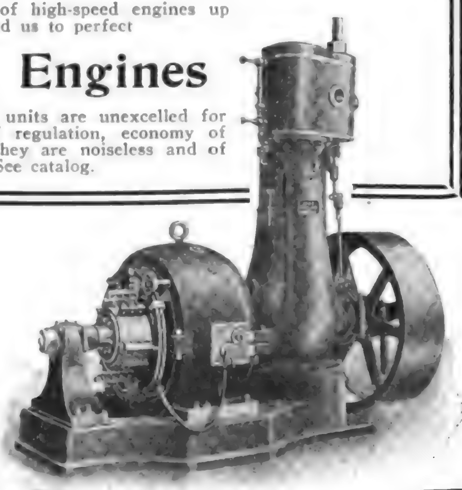

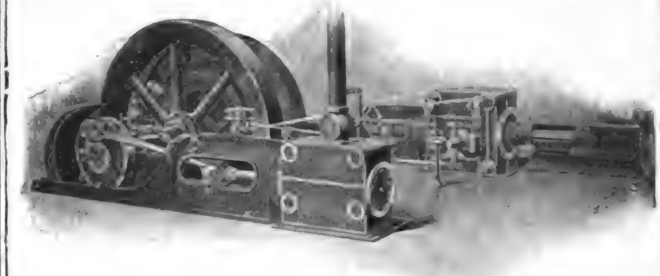

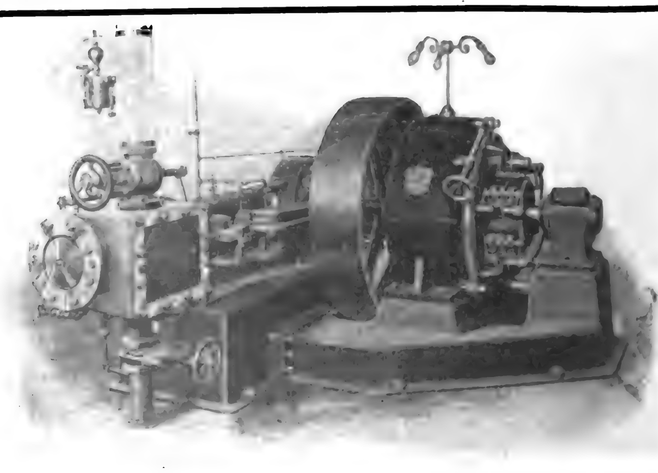

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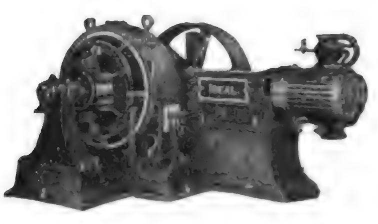

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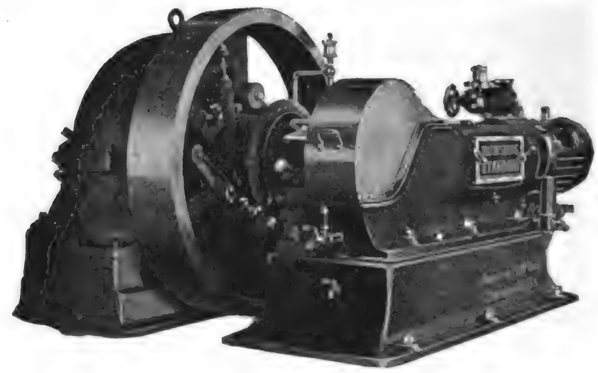

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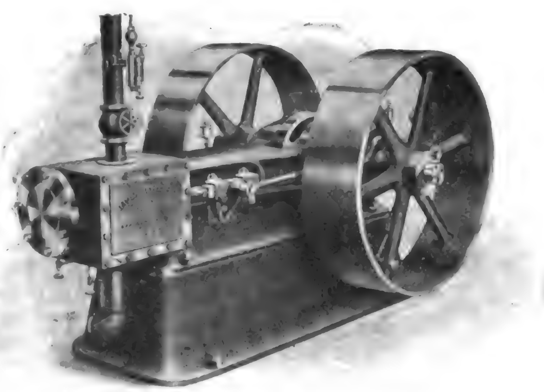

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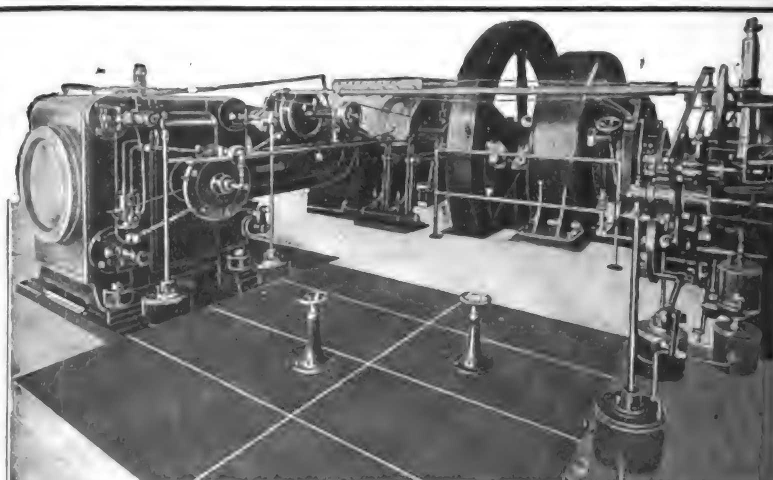

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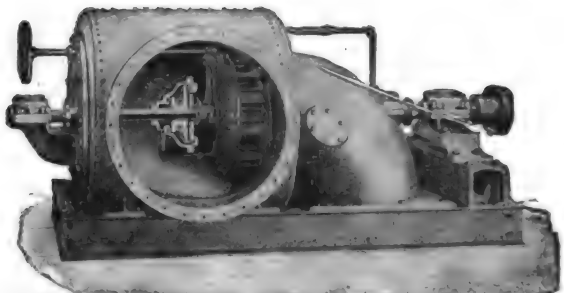

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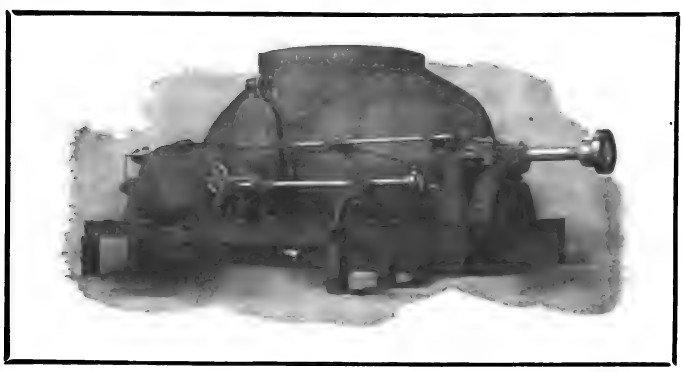

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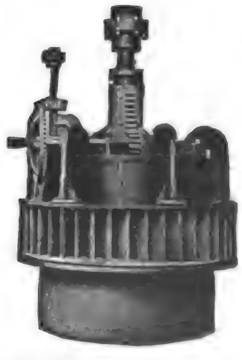

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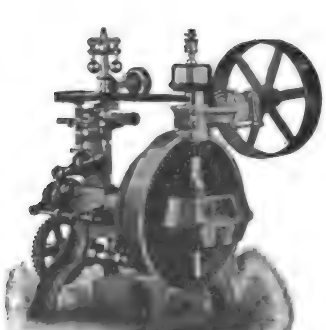

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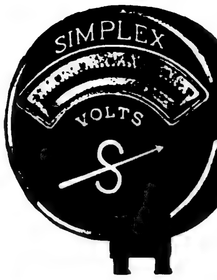

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ORIGINAL AND SOLE MAKERS IN THE U.S.

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For Direct-Current Circuits

**SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS**

ELECTROMAGNETS and SOLENOIDS

SPECIALTY—Calculation, Design and Construction of

LARGE ELECTROMAGNETS AND SOLENOIDS TO PERFORM A GIVEN DUTY

Also full line of **Small Electromagnets, Ringer Magnets, Solenoids, Telephone Induction Coils, Medical Induction Coils, Ruhmkorff Windings, Gas Lighting Spark Coils, Gas Engine Spark Coils, Everything in the Coil Line**

CHARLES R. UNDERHILL

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Scheeffer Integrating Wattmeter

WITH CASE

TYPE F

For Direct
For Alternating Current

**Dust and Bug Proof
Improved Construction**

Moving parts are extremely light, insuring a highly sensitive and accurate meter.

Write for prices and descriptive literature.

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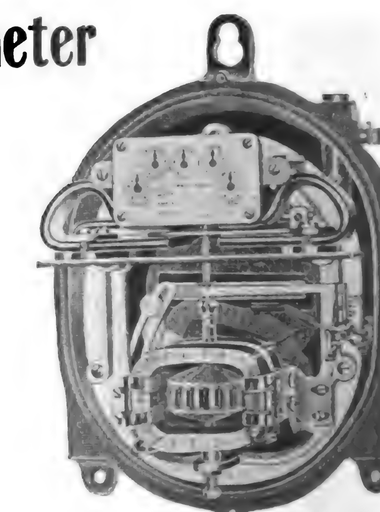
PEORIA, ILL., U. S. A.



WITHOUT CASE

Classified List of Advertisers—Continued.

Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.
Weston Electrical Instrument Co., Waverly Park, Newark, N. J.

INSULATING MACHINERY.
Aiton Machine Co., New York.

INSULATORS AND INS. MATERIALS.
Bossert Elec. Cons. Co., Utica, N. Y.
Electric Appliance Co., Chicago, Ill.
Hemingray Glass Co., Covington, Ky.
Johns-Manville Co., H. W., New York.
Macon-Evans Varnish Co., Pittsburg, Pa.
Murdock, H. D., Pittsburg, Pa.
Okonite Co., New York.
Standard Paint Co., New York.
Standard Varnish Works, New York.
Wilmington Fibre Specialty Co., Wilmington.

JEWELS.
Whitlock & Co., O. S., West Orange, N. J.

KNIVES (POCKET).
Devine Specialty Co., Indianapolis, Ind.

LAMPS, ARC.
Adams-Bagnall Elec. Co., Cleveland, O.
American Arc Lamp Co., Kalamazoo, Mich.
Fort Wayne Elec. Works, Fort Wayne, Ind.
Fox, A. W. (Theater), Brooklyn, N. Y.
General Elec. Co., Schenectady, N. Y.
Toerring Co., C. J., Philadelphia, Pa.
Warner Arc Lamp Co., Muncie, Ind.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

LAMPS, INCANDESCENT.
Bay State Lamp Co., Danvers, Mass.
Boston Inc. Lamp Co., Danvers, Mass.
Columbia Incandescent Lamp Co., St. Louis.
Elec. Equipment & Supply Co., Pittsburgh.
Electrical Testing Laboratories, New York.
Electric Appliance Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Kentucky Electrical Co., Owensboro, Ky.
McCandless & Co., H. W., New York.
Monarch Elec. Mfg. Co., Warren, O.
New York & Ohio Co., Warren, O.
Sawyer-Man Elec. Co., Pittsburg, Pa.
Sunbeam Incandescent Lamp Co., Chicago.
Warren Elec. & Specialty Co., Warren, O.

LIGHTNING ARRESTERS.
Garton-Daniels Co., Keokuk, Ia.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

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Keystone Lubricating Co., Philadelphia, Pa.

LOCOMOTIVES, ELECTRIC.
Morgan-Gardner Elec. Co., Chicago.

LUBRICATORS.
Lunkenheimer Co., Cincinnati, Ohio.

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Underhill, C. R., New York.

MECHANICAL DRAFT.
American Blower Co., Detroit, Mich.
Sturtevant, B. F. Co., Hyde Park, Mass.
Westinghouse, Church, Kerr & Co., N. Y.

METAL POLISH.
Hoffman, G. W., Indianapolis, Ind.

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Diamond Meter Co., Peoria, Ill.
Duncan Elec. Mfg. Co., Lafayette, Ind.
Sangamo Electric Co., Springfield, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

MINING MACHINERY.
Jeffrey Mfg. Co., Columbus, Ohio.
Morgan-Gardner Elec. Co., Chicago.

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Parsell & Weed, New York.

MOTOR STARTERS.
Cutler-Hammer Mfg. Co., Milwaukee, Wis.
Federal Electric Co., North Girard, Pa.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

NOVELTIES, ELECTRIC.
Denison Mfg. Co., Warren, O.

NUMBERING AND DATING MACHINES.
Bates Machine Co., New York.

PACKING.
France Packing Co., Philadelphia, Pa
Johns-Manville Co., H. W., New York.
New Jersey Asbestos Co., Camden, N. J.
Robertson, J. L., & Sons, New York.

PATENT ATTORNEYS.
Stevens & Co., Milo B., Washington, D. C.

PHOSPHOR-BRONZE.
Phosphor-Bronze Smelting Co., Philadelphia.

PHOTOMETER STANDARDS.
Electrical Testing Laboratories, New York.

PLANIMETERS.
Robertson, Jas. L., & Son, New York.

POLES, ARC LAMP.
Mott Iron Works, J. L., New York.

PORCELAIN GOODS.
Crescent Elec. Mfg. Co., Rochester, N. Y.
Freeman Elec. Co., E. H., Trenton, N. J.

POWER TRANSMISSION.
Jeffrey Mfg. Co., Columbus, O.
Platt Iron Works Co., Dayton, Ohio.
Smith, S. Morgan Co., York, Pa.

PULLEYS.
Rockwood Mfg. Co., Indianapolis, Ind.
Smith, S. Morgan Co., York, Pa.

PUMPS.
De Laval Steam Turbine Co., Trenton, N. J.
Platt Iron Works Co., Dayton, Ohio.
Stewart Heater Co., Buffalo, N. Y.

Classified Index continued on page 16

See Pages 35, 36, 37, 38.

Classified List of Advertisers—Continued

RAILWAY SUPPLIES, ELECTRIC.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

RECEPTACLES.
Electro-Dynamic Co., Bayonne, N. J.
Freeman Elec. Co., E. H., Trenton, N. J.
Paiste Co., H. T., Philadelphia, Pa.

REGULATORS, DAMPER PRESSURE.
Davis Regulator Co., Chicago.
D'Este Co., Julian, Boston, Mass.

REPAIRING, ELECTRICAL.
Chicago Edison Co., Chicago, Ill.
Cleveland Armature Works, Cleveland, O.
Heck, Louis, Newark, N. J.
Van Dorn-Elliott Elec. Co., Cleveland, Ohio.

RHEOSTATS.
Cutler-Hammer Mfg. Co., Milwaukee, Wis.
Cutter Co., Philadelphia, Pa.
Federal Electric Co., North Girard, Pa.
Westinghouse Elec. & Mfg. Co., Pittsburg.
Wirt Elec. Co., The, Philadelphia, Pa.

RIVETED STEEL.
Pelton Water Wheel Co., San Francisco, Cal.

RUBBER MILL MACHINERY.
Alton Machine Co., New York.

SCHOOLS AND COLLEGES.
Mich. College of Mines, Houghton, Mich.

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Bell Electric Motor Co., New York.
Central Station Improvement Co., Chicago, Ill.
Chicago House Wrecking Co., Chicago, Ill.
Jordan Bros., New York.
Thompson, Jos. H., Jr., New York.

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Hoppes Mfg. Co., Springfield, O.
Platt Iron Works Co., Dayton, Ohio.
Stewart Heater Co., Buffalo, N. Y.
Westinghouse, Church, Kerr & Co., N. Y.

SHADE HOLDERS.
Paiste Co., H. T., Philadelphia.

SIGNS, ELECTRIC.
Reynolds Elec. Flasher Mfg. Co., Chicago, Ill.
Colonial Sign & Insulator Co., Akron, O.

SOCKETS.
Crescent Elec. Mfg. Co., Rochester, N. Y.
Trumbull Elec. Mfg. Co., Plainville, Conn.
Yost Elec. Mfg. Co., Toledo, O.

SOLDERING IRONS.
Emmelmann Bros. Mfg. Co., Indianapolis, Ind.

SPRINGS.
Barnes Co., The Wallace, Bristol, Conn.

STEAM SPECIALTIES.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Crosby Steam Gage & Valve Co., Boston.
Davis Regulator Co., Chicago.
D'Este Co., Julian, Boston, Mass.
Harrison Safety Boiler Works, Phila., Pa.
Lippincott Steam Specialty & Supply Co., Newark, N. J.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Detroit, Mich.

STEAM TRAPS.
Albany Steam Trap Co., Albany, N. Y.
American Blower Co., Detroit, Mich.
Davis Regulator Co., Chicago.
D'Este Co., Julian, Boston, Mass.
Platt Iron Works Co., Dayton, Ohio.

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Green Engineering Co., Chicago, Ill.
Underfeed Stoker Co., Chicago, Ill.
Westinghouse, Church, Kerr & Co., N. Y.

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American Elec. Supply Co., Chicago, Ill.
Chase-Shawmut Co., Newburyport, Mass.
Electrical Equip. & Supply Co., Pittsburg, Pa.
Electric Appliance Co., Chicago, Ill.
General Elec. Co., Schenectady, N. Y.
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Manhattan Elec. Supply Co., New York.
Partrick, Carter & Wilkins Co., Philadelphia.
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Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

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Bossert Elec. Construction Co., Utica, N. Y.
C. & C. Electric Co., Garwood, N. J.
Chase-Shawmut Co., Newburyport, Mass.
Cutter Co., Philadelphia, Pa.
Electric Appliance Co., Chicago, Ill.
Hart & Hegeman Mfg. Co., Hartford, Conn.
Hart Mfg. Co., Hartford, Conn.
Pringle, W. T., Philadelphia.
Trumbull Elec. Mfg. Co., Plainville, Conn.
Waterbury & Co., New York.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.
White, H. P., Co., Ltd., Philadelphia, Pa.
Worcester Elec. Mfg. Co., Worcester, Mass.

TAPS AND DIES.
Carpenter Tap & Die Co., Pawtucket, R. I.
Standard Tool Co., Cleveland, O.

TELEPHONES.
Automatic Electric Co., Chicago, Ill.
Electric Appliance Co., Chicago, Ill.

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Classified List of Advertisers—Continued

Kellogg Switchboard & Sup. Co., Chicago, Ill.
Manhattan Elec. Supply Co., New York.
New York Telephone Co., New York.
Stromberg-Carlson Tel. Co., Rochester, N. Y.

TESTING LABORATORY.
Electrical Testing Laboratories, New York.

THEATER-DIMMERS.
Cutler-Hammer Mfg. Co., Milwaukee, Wis.
Wirt Electric Co., Philadelphia, Pa.

TOOLS.
Klein & Sons, M. (Linemen's) Chicago, Ill.
Devine Specialty Co., Indianapolis, Ind.
Roberts Elec. Supply Co.. H. C., Philadelphia.
Standard Tool Co., Cleveland, O.

TORCHES.
Emmelmann Bros. Mfg. Co., Indianapolis, Ind.
Roberts Elec. Supply Co., H. C., Philadelphia.

TRANSFORMERS.
American Transformer Co., Newark, N. J.
Crawfordsville Elec. Co., Crawfordsville, Ind.
Electric Appliance Co., Chicago, Ill.
~~Fort Wayne Elec. Works, Fort Wayne, Ind.~~
General Electric Co., Schenectady, N. Y.
Lafayette Elec. Mfg. Co., Lafayette, Ind.
Moloney Elec. Co., St. Louis, Mo.
Peerless Elec. Co., Warren, Ohio.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

TURBINE GOVERNORS.
Lombard Governor Co., Boston, Mass.
Woodward Governor Co., Rockford, Ill.

TURBINES, STEAM.
Allis-Chalmers Co., Milwaukee, Wis.
De Laval Steam Turbine Co., Trenton, N. J.
General Electric Co., Schenectady, N. Y.
Hooven, Owens, Rentschler Co., Hamilton, O.
Westinghouse Machine Co., E. Pittsburg, Pa.

VALVES.
Am. Steam Gauge & Valve Mfg. Co., Boston.
Crosby Steam Gage & Valve Co., Boston.
Davis Regulator Co., Chicago.
Ludlow Valve Mfg. Co., Troy, N. Y.
Lunkenheimer Co., Cincinnati, O.

VARNISHES.
Macon-Evans Varnish Co., Pittsburg, Pa.
Standard Varnish Works, New York.

WATER PIPE AND FITTINGS.
Pelton Water Wheel Co., San Francisco, Cal.

WATER SOFTENING and PURIFYING SYSTEMS.
Harrison Safety Boiler Works, Phila., Pa.

WATER WHEELS AND TURBINES.
Allis-Chalmers Co., Milwaukee, Wis.
Dowling & Co., Wm., Logansport, Ind.
Leffel, James, & Co., Springfield, O.
Pelton Water Wheel Co., San Francisco, Cal.
Platt Iron Works Co., Dayton, Ohio.
Risdon-Alcott Turbine Co., Mt. Holly, N. J.
Smith, S. Morgan Co., York, Pa.
Trump Mfg. Co., Springfield, O.

WIRES AND CABLES.
Amer. Electrical Works, Providence, R. I.
Crescent Ins. Wire & Cable Co., Trenton, N. J.
Electric Appliance Co., Chicago, Ill.
Hazard Mfg. Co., Wilkesbarre, Pa.
Ind. Rubber & Ins. Wire Co., Jonesboro, Ind.
Kellogg Switchboard & Sup. Co., Chicago.
Okonite Co., Ltd., New York.
Phillips Ins. Wire Co., Pawtucket, R. I.
Roebling's John A., Sons, Trenton, N. J.
Safety Ins. Wire & Cable Co., New York.
Standard Underground Cable Co., Pittsburg.
Waterbury & Co., New York.

WIRE ROPE MACHINERY.
Aiton Machine Co., New York.

When writing to advertisers, please mention the AMERICAN ELECTRICIAN.

A Contented Customer

At last my wants are well supplied,
Although I have the others tried;
Yet all good points for which I sought,
Were in that "SHAWMUT" Bushing, bought.

Uses

Shawmut

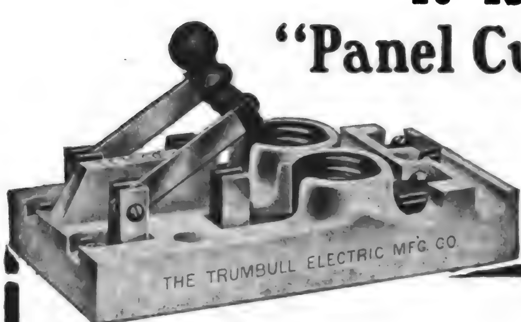
Outlet  **Bushings**

HAVE YOU TRIED THEM?

Then see Bulletin No. 31

CHASE-SHAWMUT CO.
NEWBURYPORT, MASS.

If it isn't a Trumbull it isn't a "Panel Cutout"



You can't carry panel boards in stock, because you can't tell just what you're going to need; but you can do better—you can carry a few Panel Cut-outs, and your wiremen can construct their panel boards at the very time they're needed.

When rough wiring, the wireman runs his branch circuits into the usual distributing box, and, when finishing up, puts in the necessary number of Panel Cut-outs.

Besides saving much time and trouble, Panel Cut-outs save on the first cost, for a distributing board can be constructed with them at one-third the cost of a slate panel board.

Order a few to-day, and see how much they'll save *you.*

The Trumbull Electric Mfg. Co.
614 Woodford Ave., Plainville, Conn.
New York, 136 Liberty St.

VULCABESTON

THE TEST OF TIME

TIME REVEALS ALL THINGS

IT is TIME that brings out the flaws and imperfections that when young were carefully hidden by clever workmanship on the surface only.

It is the same TIME that VULCABESTON has so very successfully withstood and still stands.

It is the same TIME that has shown VULCABESTON in its true colors—the most efficient, durable, and reliable insulation ever manufactured.

VULCABESTON for years has STOOD THE TEST and proven its superiority over all other insulating materials.

VULCABESTON has very high insulating properties and great tensile strength.

It can be moulded into innumerable shapes suiting it for all conditions and requirements.

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Manufacturers of Asbestos and Magnesia Pipe and Boiler Coverings, Asbestos Packings, Roofings, Etc.
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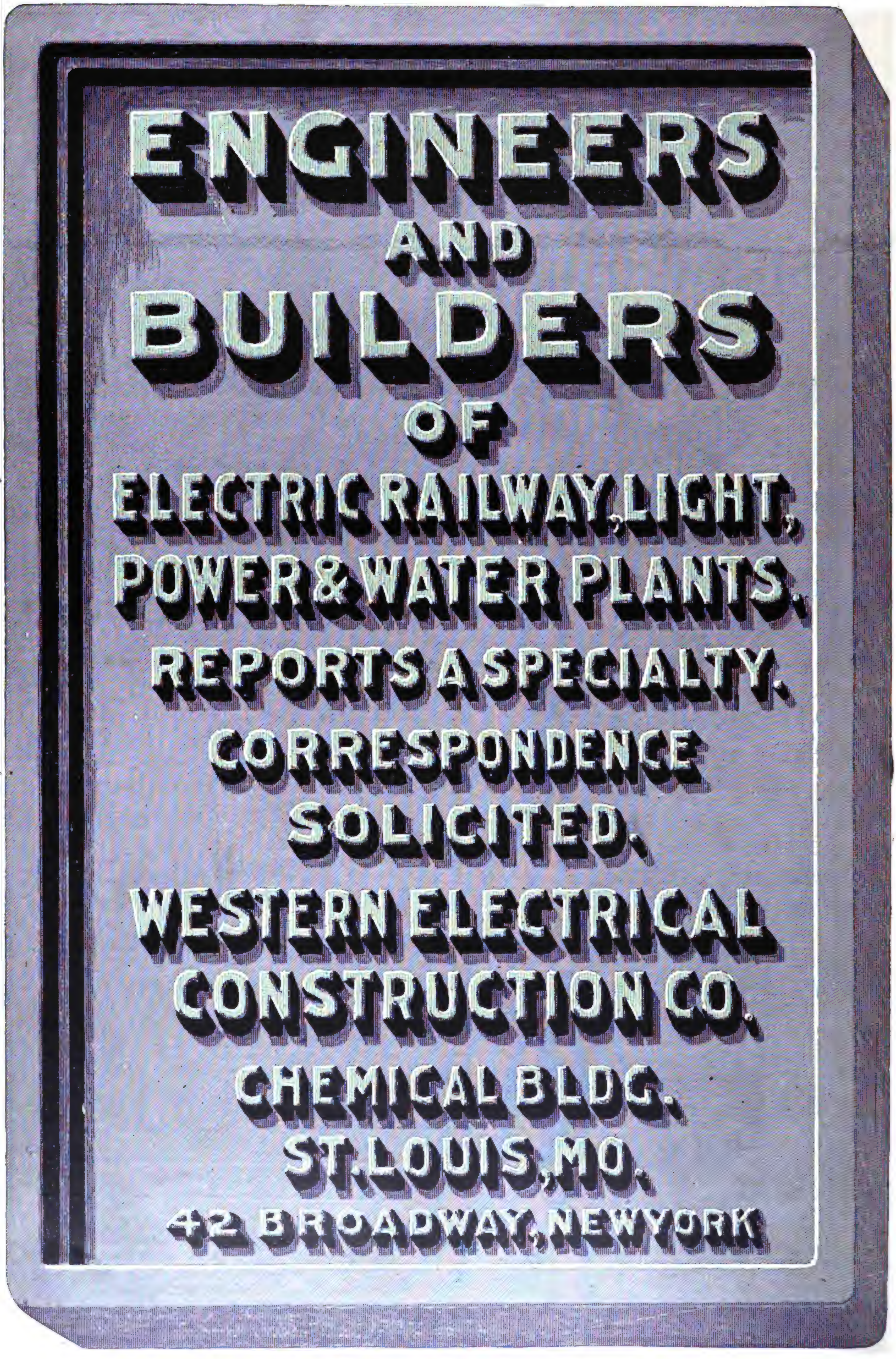
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AND
BUILDERS
OF
ELECTRIC RAILWAY, LIGHT,
POWER & WATER PLANTS.
REPORTS A SPECIALTY.
CORRESPONDENCE
SOLICITED.
WESTERN ELECTRICAL
CONSTRUCTION CO.
CHEMICAL BLDG.
ST. LOUIS, MO.
42 BROADWAY, NEW YORK

The C-H Rotary Press Controller

In the control of motor-driven rotary presses the two extremes of speed are demanded. Very slow speed for setting up the plates and threading in the paper, and "hurry up" speed to make up for delays in going to press.

In most control systems, to obtain slow speeds a second motor is necessary. With the Cutler-Hammer Rotary Press Controller but one motor is required for both the slowest and highest speeds, and it also provides for a large number of intermediate speeds. At any and every speed it gives a steady motion to the press, and prohibits its jumping, no matter how heavy it may be loaded.

This controller is so arranged that there is absolutely no arcing on the segments, the opening of the motor circuit being accomplished by the large solenoid shown in the cut. This solenoid is equipped with a carbon break and blow-out magnets for disrupting the arc. Protective devices are provided to quickly stop the press in case of accident.

Our Bulletin No. 65 tells about this type.

Cutler-Hammer Mfg. Company

MILWAUKEE, WISCONSIN

NEW YORK	BOSTON	CHICAGO	PITTSBURG
136 Liberty St.	176 Federal St.	Monadnock Bldg.	Farmers Bank Bldg.

California

This Winter

The riches of health and the joys of a whole year are in a California winter.

California is not far away.

Fully two days nearer the Atlantic Coast than it was a few years ago. Correspondingly nearer from all Middle West points.

Plan your winter's trip NOW.

The cost of tickets is the SAME by all direct lines.

The service, scenery and accommodations are DIFFERENT.

On the Rock Island's Southern route, via El Paso, there are two fast through trains daily from Chicago and St. Louis.

It is the line of lowest altitudes and longest level stretches—the quickest route.

On the Rock Island's Scenic route, through Colorado and Salt Lake City, there are Standard and Tourist Pullmans through without change.

Write to-day for maps and booklets.

Rock Island System

JOHN SEBASTIAN,
P. T. M. Rock Island System,
CHICAGO

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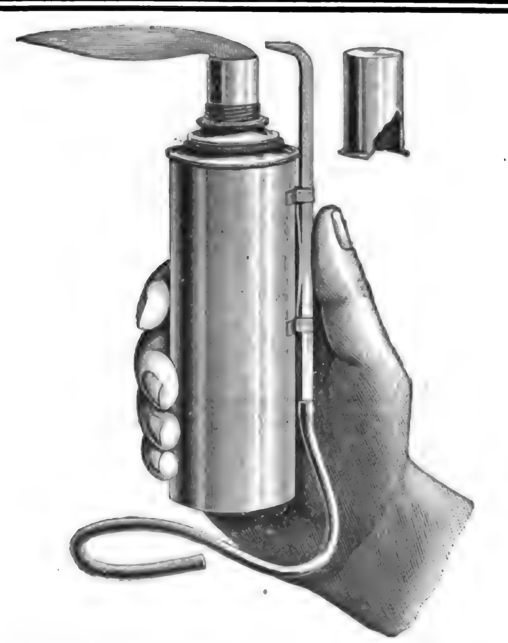
FOR ELECTRIC LIGHT, RAILWAY, TELEGRAPH AND TELEPHONE CONSTRUCTION

TOOLS FOR ELECTRICIANS



Roberts Patented Alcohol Torch

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H. C. ROBERTS ELECTRIC SUPPLY CO.

WHOLESALERS OF ELECTRICAL SUPPLIES

905 ARCH STREET, PHILADELPHIA, PENNA.

HEMINGRAY

STANDARD SCREW GLASS INSULATORS

7 IN. MUNCIE TYPE
Guarantee 40,000 Volts

THE BEST FOR ALL PURPOSES

No. 1 HIGH VOLTAGE
Guarantee 10,000 Volts

ALL WITH THE

"Patent Drip Petticoats"

They take all the moisture from the inner and outer surface of the insulator and keep the pin dry

No. O PROVO TYPE
Guarantee 50,000 Volts

Telegraph, Telephone, Railway, Power

The Hemingray Glass Co.

ESTABLISHED 1848

Office, COVINGTON, KY. Factory, MUNCIE, IND.

The Greatest Event in Electrical Journalism

On January 1, 1906, the *American Electrician* will be consolidated with the *Electrical World and Engineer*, the combined paper being thereafter known as the

ELECTRICAL WORLD

An outline of the plans for this consolidation, together with announcements of importance to advertisers and subscribers will be found on the following pages

McGRAW PUBLISHING COMPANY

The New
ELECTRICAL WORLD

Consolidation of "Electrical World and Engineer" and "American Electrician"

On January 1st, 1906, the Electrical World and Engineer and the American Electrician will be united and the consolidated journal will thereafter be known as the ELECTRICAL WORLD.

For a number of years there were separate places to be filled in the electrical field by a weekly and monthly publication, but owing to the evolution of the industry conditions have arisen which make it desirable from the standpoint of the manufacturer, the reader, the advertiser, and the publisher that these two important periodicals should be consolidated.

The Electrical World and Engineer is in itself a combination of the Electrical World and the Electrical Engineer. The Electrical World dates back to 1874 and was always recognized in the industry as incontestably the leading electrical paper. The Electrical Engineer was published separately from 1882 to 1899 and held the second position in importance in the field.

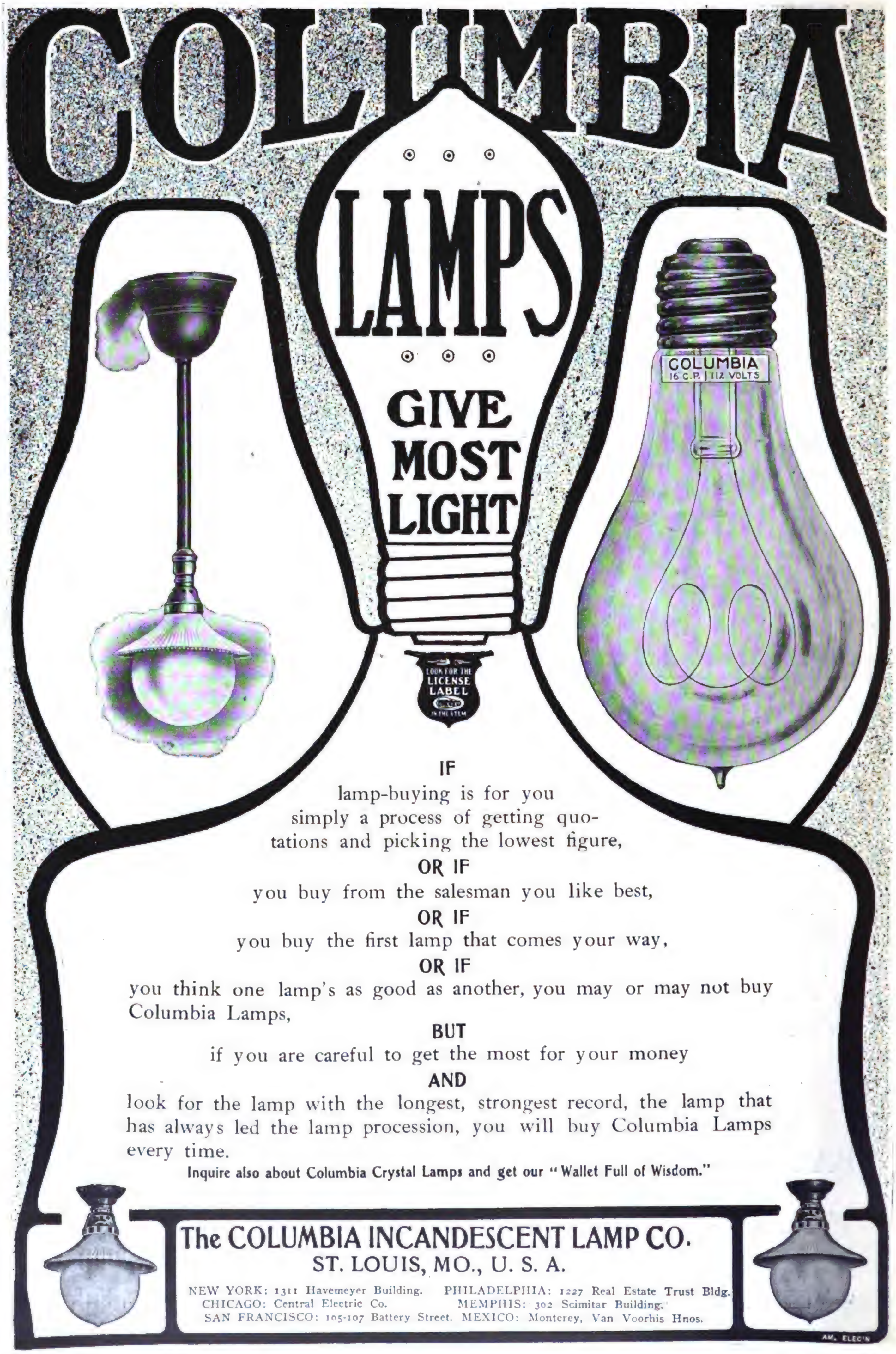
The progress of the industry having reached a point where it was desirable that these two papers should be combined and thereafter be published as one large weekly paper, the present owners took the necessary steps to accomplish this purpose and the Electrical World and Engineer was the result. During the past seven years this paper has more than ever occupied a unique position among technical journals, in that it has been accepted the world over as the one great exponent of the electrical art.

The American Electrician through its predecessor, Electrical Industries, dates back to 1889. Its subscription is the largest of all electricai journals, and it has earned for itself the reputation of being the only strong electrical monthly ever published.

Although the paid circulations of the two papers have overlapped less than 10 per cent., the tendency has been steadily toward a greater similarity in the character of the reading pages. Notwithstanding the considerable sacrifice on the part of the publishers, the consolidation will be justified, as the result will be an electrical journal of unprecedented strength, combining the engineering, technical, practical and commercial features of the component journals, and interesting every man engaged in the art or industry, from the consulting engineer or the superintendent of the large power station to the engineer of the isolated plant or the smallest electrical contractor.

The first issue of each month will contain the special practical features which have heretofore characterized the American Electrician. The second issue of the month will be the regular export issue, and, as in the past, every effort will be made to extend the foreign field for the benefit of those advertisers who are interested in export business.

The advertising rates in the Electrical World will be based upon the page unit instead of the inch, but the present flexible form of contract, which has met with so much favor, will be retained. That is to say, an advertiser who agrees to use a certain number of pages during the year, the space to be divided as he desires, and who for any unforeseen reason fails to use the entire number of pages contracted for, will pay for the advertising actually published at the rates applying to that amount of space.


COLUMBIA
LAMPS
GIVE
MOST
LIGHT
COLUMBIA
16 C.P. | 112 VOLTS
LOOK FOR THE
LICENSE
LABEL
IF
lamp-buying is for you simply a process of getting quotations and picking the lowest figure,
OR IF
you buy from the salesman you like best,
OR IF
you buy the first lamp that comes your way,
OR IF
you think one lamp's as good as another, you may or may not buy Columbia Lamps,
BUT
if you are careful to get the most for your money
AND
look for the lamp with the longest, strongest record, the lamp that has always led the lamp procession, you will buy Columbia Lamps every time.
Inquire also about Columbia Crystal Lamps and get our "Wallet Full of Wisdom."
The COLUMBIA INCANDESCENT LAMP CO.
ST. LOUIS, MO., U. S. A.
NEW YORK: 1311 Havemeyer Building. PHILADELPHIA: 1227 Real Estate Trust Bldg.
CHICAGO: Central Electric Co. MEMPHIS: 302 Scimitar Building.
SAN FRANCISCO: 105-107 Battery Street. MEXICO: Monterey, Van Voorhis Hnos.

Complaints
Are Never Necessary When You Use
PEERLESS LAMPS

LOOK FOR THE LICENSE LABEL IN THE STEM

Every Peerless Lamp is as nearly perfect as skill and care can make it. You will never find that any particular shipment is not up to the average. You will never have to jump on your dealer. You will never have to order substitutes.

Let the other fellow do the worrying.

"Purchase Peerless" and be happy.

The
Warren Electric & Specialty Co.
Warren, Ohio.

FOR SALE.

RUBBER COVERED COPPER WIRE.

A chance to save from 30 to 50 per cent. on your purchase. We have in stock for immediate delivery the following quantity of Rubber Covered Copper Wire, all of the American Steel & Wire make, used temporary at the LOUISIANA PURCHASE EXPOSITION, and which we secured in connection with our purchase of the entire World's Fair. This wire has been carefully inspected and selected, and all short lengths not practical for further use have been scrapped. The wire that we are offering you is just as good as new for further use.

No. 14—1,000,000 feet.
No. 12—750,000 feet.
No. 10—450,000 feet.
No. 8—120,000 feet.
No. 6—400,000 feet.
No. 5—15,000 feet.
No. 4—125,000 feet.
No. 3—45,000 feet.
No. 2—25,000 feet.
No. 1—30,000 feet.
No. 1/0—24,000 feet.
No. 2/0—95,000 feet.
No. 3/0—50,000 feet.
No. 4/0—224,000 feet.
400,000 C. M. 10,000 feet.
500,000 C. M. 50,000 feet.
750,000 C. M. 1,000 feet.
Also No. 8 for 8,000 Volt—9,000 feet.

NEW SLOW BURNING WEATHERPROOF WIRE.

50,000 lbs. Nos. 14, 12 and 10 brand new American Steel & Wire Slow Burning Wire in original coils, just as received from factory.

Also new Stranded Slow-Burning Wire on reels, sizes 2/0 and 3/0.

FEEDER WIRES.

The following Stranded Feeder Wires in stock for immediate shipment:
500,000 C. M.—60,000 lbs.
400,000 C. M.—150,000 lbs.
2/0—90,000 lbs.

SOLID CONDUCTOR WEATHERPROOF WIRE.

All sizes from No. 14 to No. 1. Some of it brand new and some second-hand.

LEAD COVERED CABLES.

An enormous stock of new and second-hand "Safety" Rubber Insulated lead covered cables from size No. 14 to 500,000 C. M.

INCANDESCENT LAMPS.

100,000 brand new General Electric Incandescent Lamps, in original cases, just as shipped from factory, packed 200 and 400 to the case. They are all 8-candle-power, 100, 101, 102 and 103 voltage, Edison Base. In case lots, each, 11 cts.

25,000—Brand new General Electric Incandescent Lamps, natural colors: Ruby, Green, Amber and Opal, packed 200 and 400 to the case, Edison Base, 104 voltage, 8-candle-power. In case lots, each, 21 cts.

500,000—Second-hand, tested 8 candle-power Incandescent Lamps, Edison Base, 104 to 110 voltage. Price in lots of 500, 6 cts. each.

RECEPTACLES.

1,000,000—No. 9171 Edison Base Receptacles in lots of 500, each, 2 cts.

KNOBS.

50,000—Split B. & D. Porcelain knobs, No. 10 to No. 14 wire, per thousand, $7.00.

40,000—No. 8 to No. 4 wire, per thousand, $10.00.

30,000—No. 6 to 2/0 wire, per thousand, $10.00. The above are brand new and in original packages.

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POSITION WANTED AS SUPERINTENDENT or electrician of power and light plant in small town, by young man with 14 years' practical experience. Direct or alternating current. Best of references. Address "HOLMES," 20 Whittemore St., Arlington, Mass.

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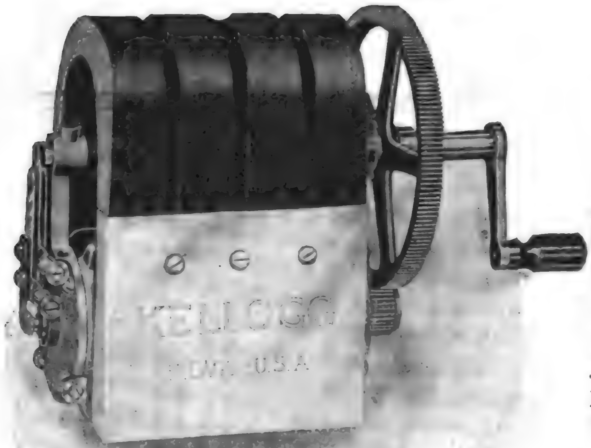

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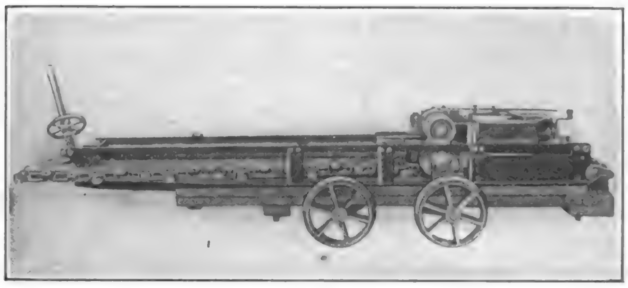

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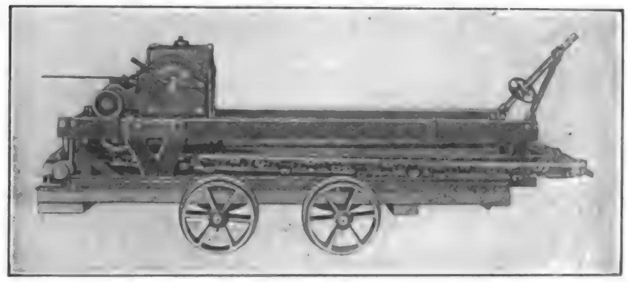

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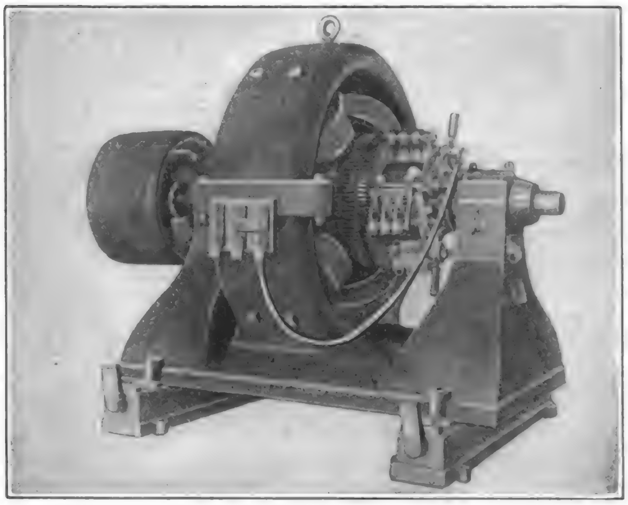

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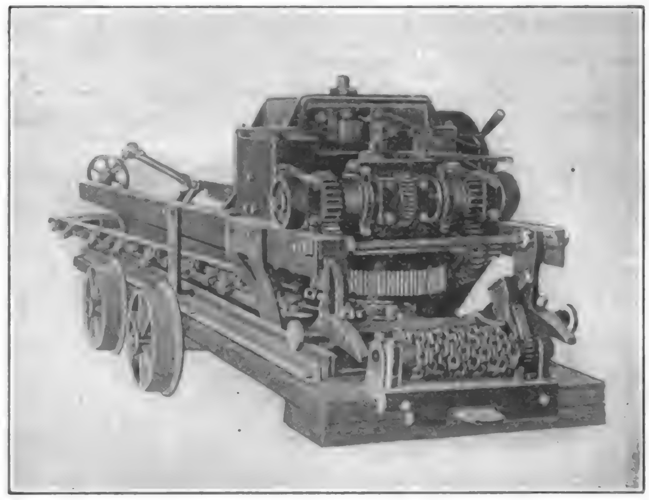

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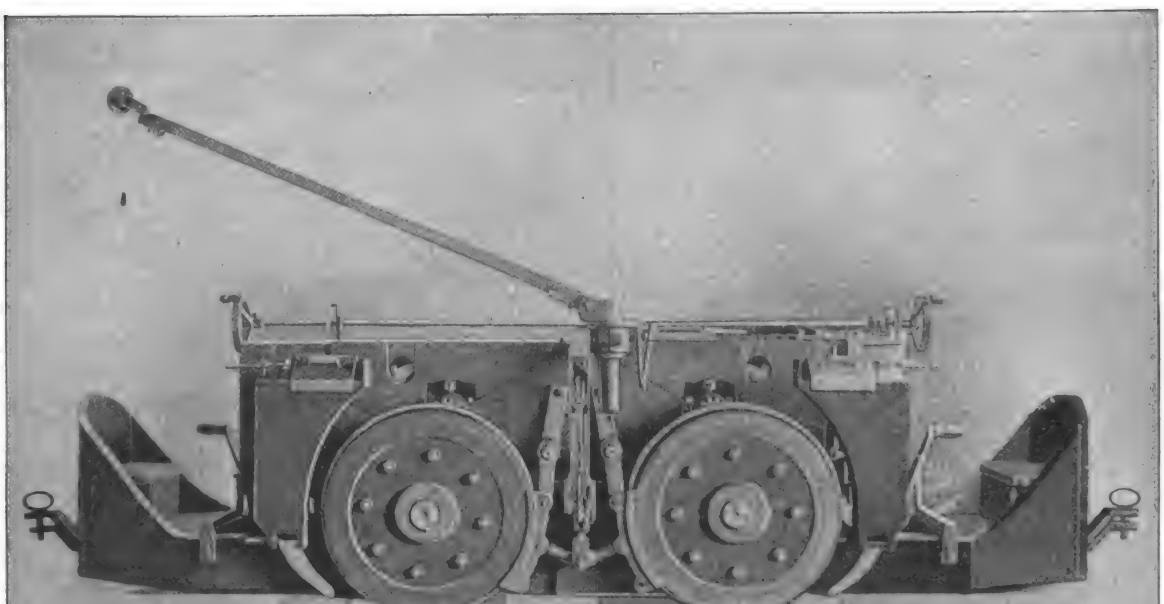

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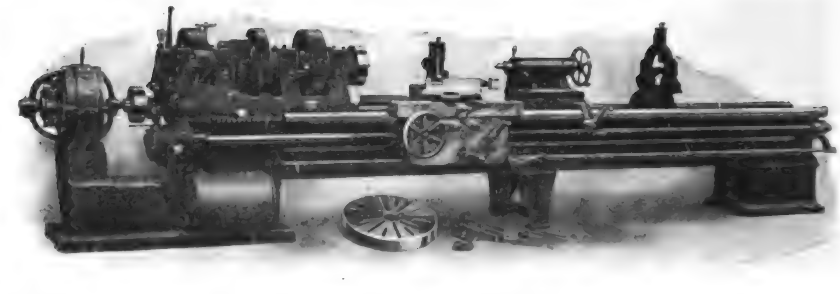

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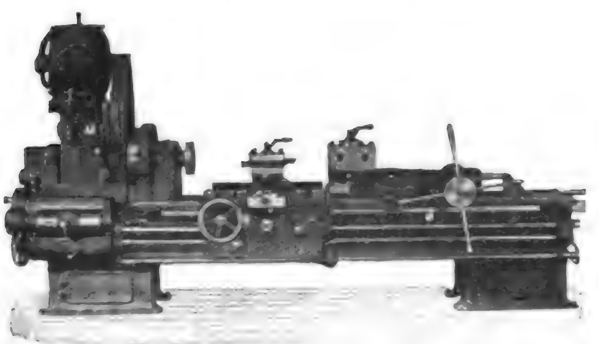

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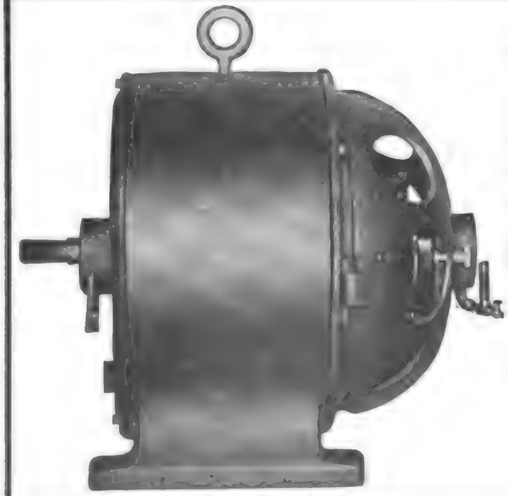

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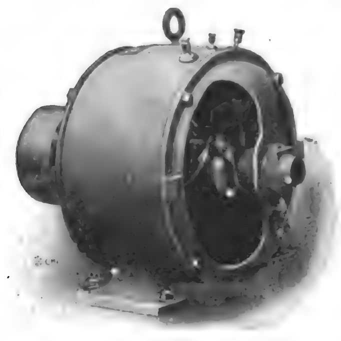

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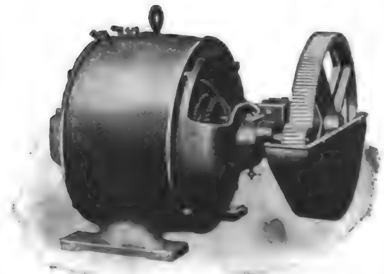

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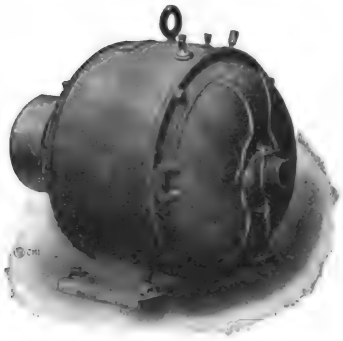

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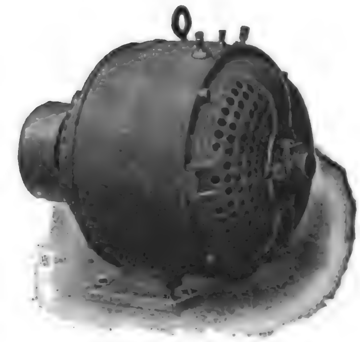

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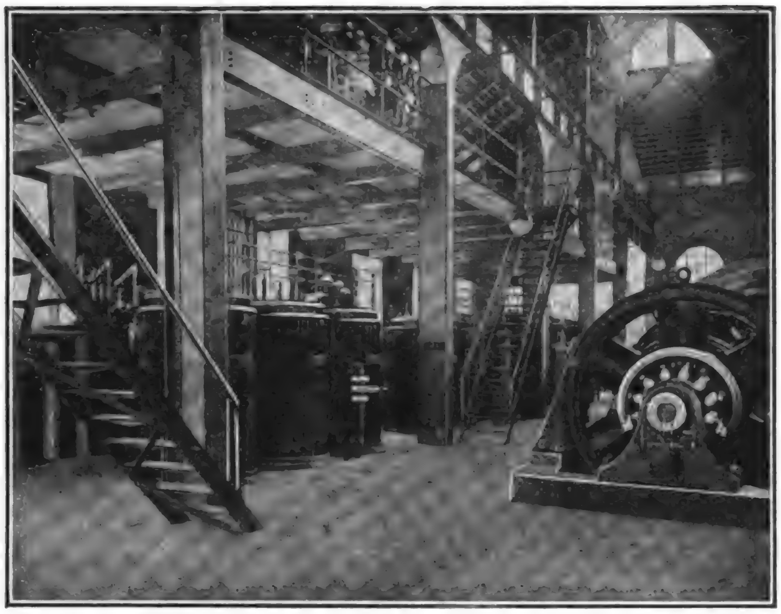

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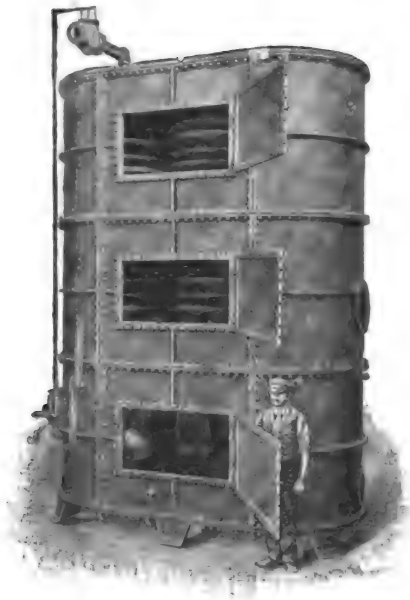

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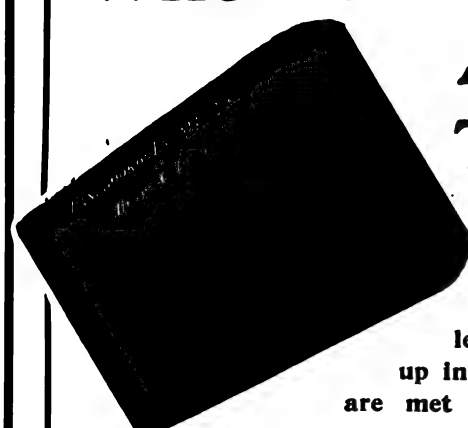

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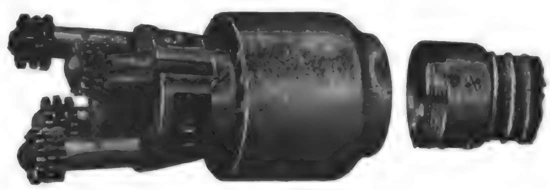

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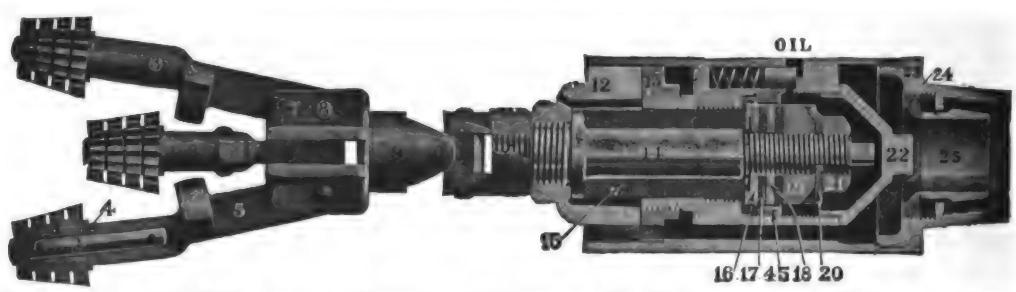

The Liberty Turbine Cleaner

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Are you sure your boilers are clean?

The fact that you use a light Turbine Cleaner and pass it through the tubes at frequent intervals, is no indication that the scale is removed. Other types of machines ride over the scale, whereas the Liberty removes it down to the iron, polishing up the tube and leaving it in as good condition as it was when the boilers were new.

The Liberty is the only Cleaner in existence that will do this.

One-eighth of an inch of scale means fifteen per cent more coal to evaporate the same amount of water as compared to clean tubes.

Liberty Cleaners are sent to responsible parties on trial.

In the end it is the cheapest Cleaner in existence.

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is an important problem in every power plant. The cost of fuel is generally the largest item of expense and every pound of steam that is saved is made apparent in the coal bills.

A direct saving can be effected in most plants by using steam for various purposes at pressures less than the boiler pressure and for this service *Davis Pressure Regulators* are designed.

By their use any high initial pressure can be reduced any amount, and when once set to the desired delivery pressure they will automatically maintain that pressure constant irrespective of any fluctuation in the initial pressure.

They are simple in design, being constructed of few parts and have no springs, diaphragms, packings or toggles to get out of order or fail at inopportune times.

They are made for long, hard, continuous service and have established just such a reputation in the many years they have been on the market.

We want you to become familiar with the merit of these Valves —to determine their value by actual service tests—and we are willing to take all the chances.

To responsible concerns we will send a *Davis Pressure Regulator free on trial* with the understanding that it will be paid for if found entirely satisfactory after having been fully tested, or returned at our expense in the event of a failure.

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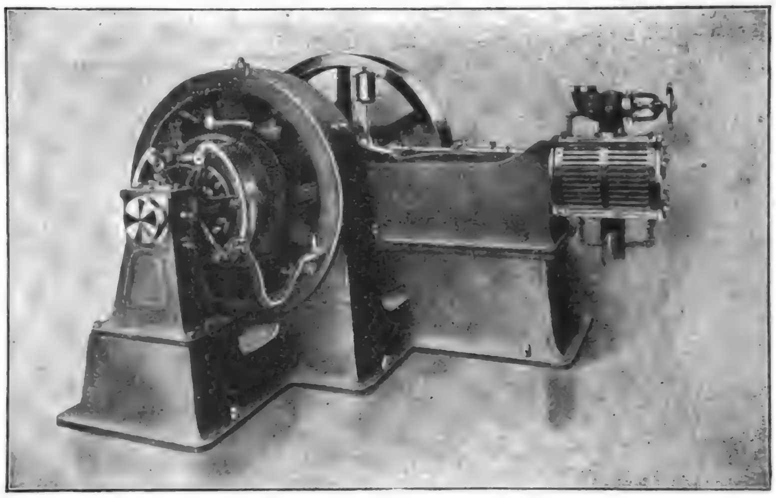

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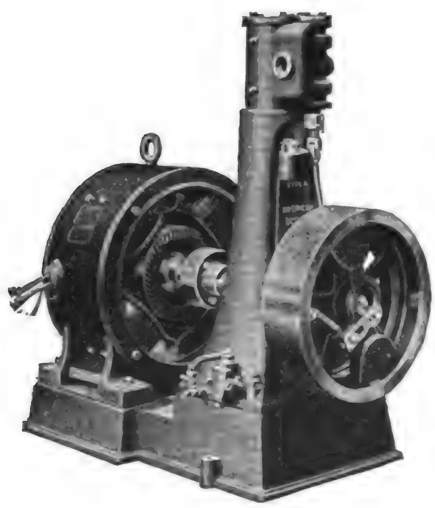

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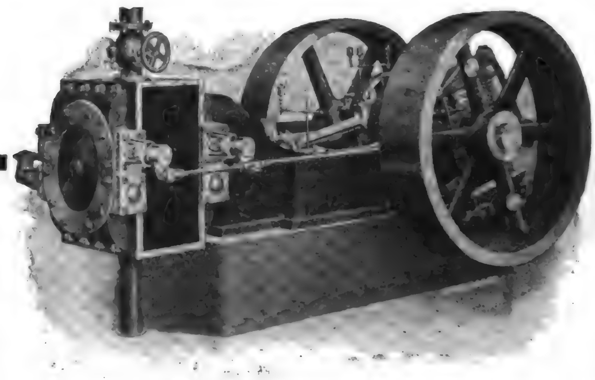

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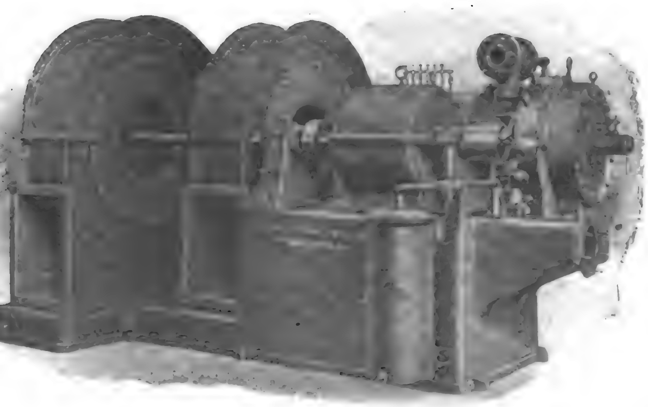

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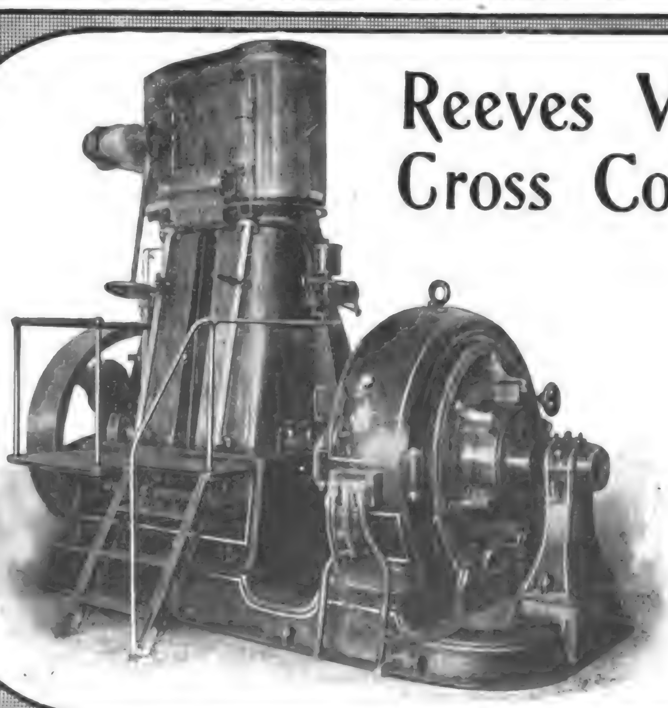

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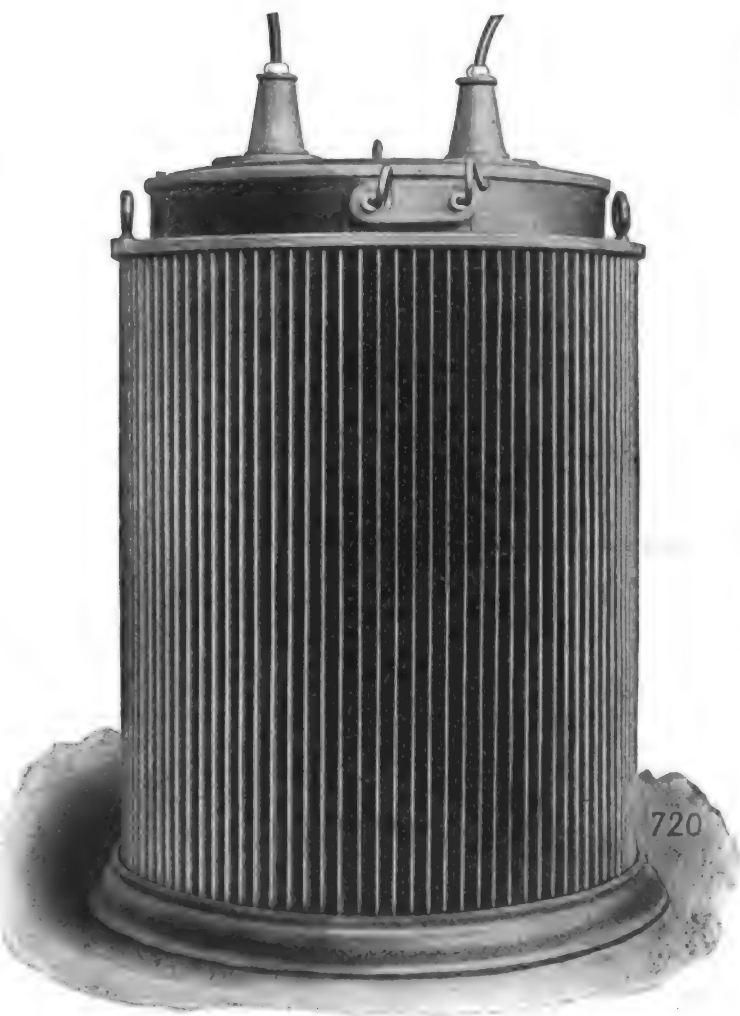

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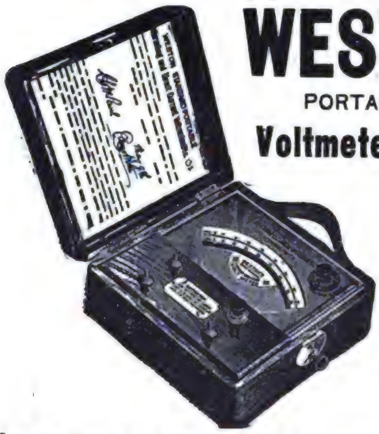

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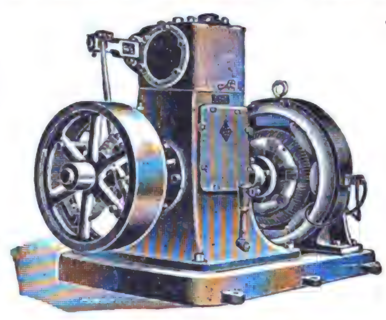

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